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SELECTED EFFECTS OF CONTRACTOR REACTIONS TO STANDARDIZATION OF AVIONICS ACQUISITIONS.

Jeffrey W. Ackerson, Captain, USAF
George H. Baum, GS-12

LSSR-64-80

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This study surveyed the attitudes of avionics contractor community regarding the effects of varying degrees of avionics standardization on their company's market position, and their perception of how these levels would affect equipment availability, acquistion cost, ownership cost, and technological advancement to the USAF. A structured attitudinal survey and an open-ended set of questions were used to obtain the contractor's attitudinal position. The following conclusions can be implied: increasing levels of standardization will adversely affect company's market position; increasing standardization will increase equipment availability, increase acquistion costs, decrease ownership costs, and adversely affect technological advancements. Additionally, there appears to be a high degree of interest to maintain competition in the market, obtaining multi-year contracts, resolving the requirement for specialization or generalization in avionics, and getting more System Program Office attention to avionics standardization issues. Various recommendations are proposed to help resolve this issues.

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SELECTED EFFECTS OF CONTRACTOR REACTIONS TO STANDARDIZATION OF AVIONICS ACQUISITIONS

A Thesis

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

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In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Logistics Management

By

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June 1980

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CHAPTER I

Introduction

The United States Air Force objective for avionics acquisition is "to provide cost-effective, supportable avionics systems." [3:2-1] In support of this objective, the USAF has developed certain avionics standardization initiatives that have received a great deal of emphasis in the past few years as a necessary method to reduce spiraling support costs. However, there currently exists little published evidence to indicate whether the Department of Defense avionics contractors will accept, endorse and support basic Air Force avionics standardization policies.

> According to the Aerospace Industries Association, the more stringent procurement initiatives enunciated by the head of the Air Force Systems Command are praiseworthy goals, but several objectives, such as more standardization.. reflect an unfair view of the private sector. [1:65]

Statement of the Problem

The United States Air Force is currently proceeding with standardization policies on avionics. As these policies are implemented, there could be an effect to the USAF on the availability and relative acquisition/ownership cost of avionics components due to contractor production acceptance/rejection. Availability and cost may be related to the contractor's perception of, acceptance, or rejection of USAF standardization policies. As such, there exists a possible interrelationship between standardization and acceptance/rejection

by the private sector. This project will attempt to determine if a interrelationship exists.

Justification of the Study

In support of the defined USAF avionics acquisition objective, there has been an increasing effort by the USAF to standardize avionics end items and components on various weapons systems. While there has been extensive research conducted regarding the effects of avionics standardization on technology, architecture, and logistics support; there has been little effort devoted to determining the effects of these policies on the contractor and his resultant acceptance or rejection of USAF standardization initiatives. A detailed evaluation of the individual contractor's perspective and position regarding these initiatives is required to determine the effectiveness of these goals. Support, cost and ultimately mission accomplishment of USAF Tactical and Strategic forces hinge on the support available from the private sector. Before a comprehensive standardization program is developed, implemented, and realized, the contractor's point of view and position must be ascertained.

Delimitation of the Problem

This study is limited to the effect of differing standardization levels on USAF avionics acquisitions in the following areas: company position, equipment availability, acquisition costs, ownership costs, and technological advancement. While the scope of this problem includes all avionics acquisitions within the Department of Defense, the authors have limited

the problem to include only the USAF.

Definition of Terms

1. Acquisition - The aggregation of efforts related to developing, producing, and deploying a product to the user. Acquisition begins with approval of a mission need and ends when the last unit is provided. {12:1-2}

2. Acquisition Cost - The cost of research, development, test, and evaluation (RDT&E), production or procurement of the end item, and the initial investments required to establish a product support capability (e.g., support equipment, initial spares, technical data, facilities, training, etc.) {12:1-2}.

3. Avionics - All the electronic and electromechanical systems and subsystems (hardware and software) installed in an aircraft or attached to it. Avionics systems interact with the crew or other aircraft systems in these functional areas: communications, navigation, weapons delivery, identification, instrumentation, electronic warfare, reconnaissance, flight controls, engine controls, power distribution, and support equipment. {11:1-1}

4. Common/Commercial Avionics - Avionics equipment that can be used in many aircraft. {3:xxx}

5. Core Avionics - Avionics such as multiplexiers, processors and software. {3:xxx}

6. Company Position - The attitude of the interviewee concerning the effect of various levels of standardization on his company's operation.

7. Current Avionics Standardization Policy - This policy states that common avionics equipment that perform a particular function for more than one system will be used on more than one aircraft type. The technical requirements for this avionics equipment would emphasize wide applicability, use mature technology, have an architecture suitable for standardized interfaces and would be required in quantities large enough to realize savings and support costs will be considered.

8. Deputy for Avionics Control - The agency responsible for avionics acquisition planning and enforcement throughout the USAF. Its charter was established in AFR 800-28, Air Force Policy on Avionics Acquisition and Support.

9. Equipment Availability - This is the measure of the degree to which an end item is physically on hand within an organization. This item must be operable and in a committable state at the start of a mission.

10. Interchangeability - Exchanging one piece of equipment for another without changing the external interfaces on its architecture. This does not imply equipment commonality, but only that the two pieces of equipment are compatible in form, fit, and function. {11:1-1}

11. Interoperability - The ability of systems to provide information to, and accept information from other systems and to use the information exchanged to operate together effectively. {11:1-1}

12. Maximum Avionics Standardization Level - This level would

require that a particular piece of avionics equipment would be utilized on a fleet wide basis. Examples would be a standard TACAN for all USAF aircraft; a standard secure voice radio for all aircraft requiring this capability; and a standard bombing-navigation system for all bomber aircraft.

13. Minimum Avionics Standardization Level - This level would require a particular piece of avionics equipment to be utilized on one particular weapon system. Examples would be a standard TACAN for all F-4 aircraft; a standard secure voice radio for all C-141 aircraft; and a standard bombing-navigation system for all B-52 aircraft.

14. Mission Avionics - Avionics that are mission peculiar. {3:xxx}

15. Ownership Cost - The cost of operation, maintenance, and follow-on logistics support of the end item and its associated support systems. The terms "ownership cost" and "operating and support costs" are synonyous. {12:1-2}

16. Standard Avionics - Those pieces of common avionics equipment that perform a particular function for more than one system. {11:1-1}

17. Standardization - The process by which the Department of Defense achieves the closest practicable cooperation among the services and Defense agencies for the most efficient use of research, development and production resources, and agrees to adopt on the broadest possible basis the use of common, compatible, or interchangeable supplies, components, weapons or equipment.

18. Technological Advancement - The ability of the government or the private sector to improve the capability, effectiveness, or efficiency of existing avionics systems or to develop new avionics systems to counter existing or expected threats or deficiencies.

RESEARCH OBJECTIVES

The main goal of this project is to determine if a relationship does exist between standardization of USAF avionics components and company position; standardization and USAF equipment availability; standardization and acquisition costs to the USAF; standardization and ownership costs to the USAF; and standardization and technological advancement.

Research Question Number One

Will changing the levels of standardization in avionics acquisitions have an effect on his/her company's position.

Research Question Number Two

Will changing the levels of standardization in avionics acquisitions have an effect on forecasted USAF equipment availability delivered from the private sector?

Research Question Number Three

Will changing the levels of standardization in avionics acquisitions have an effect on USAF acquisition costs as perceived by the private sector?

Research Question Number Four

Will changing the levels of standardization in avionics acquisitions have an effect on ownership costs as perceived by the private sector?

Research Question Number Five

Will changing the levels of standardization in avionics acquisitions have an effect on technological advancement as perceived by the private sector?

SUMMARY

The basic objective of the USAF for avionics acquisitions is "to provide cost-effective, supportable avionics systems". {3:2-1}To accomplish this objective, USAF is strivtoward standardization in avionics acquisitions. As previously implied by Aerospace Industries Association, the private sector is duly concerned with standardization efforts. A measurement of this concern; and a determination of how it will affect availability, acquisition cost, ownership cost, and technological advancement is required to ascertain its full impact on USAF. This thesis will attempt to measure the private sector's concern, determine the effect, and evaluate the contractors' position.

Overview of Remaining Chapters

This overview briefly outlines the remaining chapters of this thesis. In Chapter II, a background investigation of the Air Force and the private sector avionics standardization issue will be reported. Chapter III will present the research methodology and procedures for gathering and analyzing data. In Chapter IV, the data obtained will be analyzed, hypotheses tested, and findings presented. Chapter V will contain the authors' conclusions and recommendations.

CHAPTER II

BACKGROUND

USAF Position

The issue of avionics standardization has received a great deal of attention in recent years. In his address to aerospace industry leaders, in April 1979, Gen. Alton D. Slay, Commander of the Air Force Systems Command, stated in regard to standardization:

> Industry and the Air Force view that (standardization) is the least common denominator. Why do we have to have 26 different types of inertial auto navigation systems all doing the same thing? Now, we do have a standard strategic doppler radar, even down to the modules. {10:20}

There has been a continuous effort by the Air Force, especially in the past few years, to integrate Gen. Slay's ideas into the avionics field specifically. The ever changing need for new avionics systems has resulted in an environment of rapidly changing technology that has lead to a constant upward spiraling of life-cycle costs.

> Avionics systems proliferation, resulting primarily from rapidly increasing technology, has an will continue to, increase system life-cycle costs. Included in these costs are those for research and development, production and operation and support. Individually developed systems incur separate costs in each of these areas. As a result, Air Force efforts toward avionic standardization has increased considerably. This is evidenced by establishment of the Air Force's Deputy for Avionics Control. This office, ASD/AFAL/AX, is responsible for development and administration of the Avionics Master Plan. Briefly, the Avionics Master Plan aids in the control of the avionics acquisition process. It serves as a baseline against which all programs are compared with

> the objective that forcewide standardization is continually pursued. {11:12}

The Air Force is striving to control costs in an uncertain economic and budgetary environment, and as a result is continually reviewing its policies to establish a criteria that is most beneficial to the service. Standardization of avionics is expected to play an increasing and important role for many years to come. A high ranking official in the Deputy for Avionics Control proposed:

> Avionics standardization has received a great deal of policy emphasis in the past few years as a necessity to reduce spiraling support costs. It is a real and sometimes controversial issue, and the perspective presented here comes from today's technology, current Department of Defense policies, budget trends and problems which are upon us today. The perspective comes from recognizing the real world fact that for the next decade, avionics improvements in Air Force aircraft will come almost exclusively through retrofit with the attendant problems of meshing new technology into old avionics architectures. There is no question that the rapid advances in digital technology will continue to push us toward more highly integrated avionics systems and subsystems and require us to evolve standardization tools suitable to the new systems. {8:1}

To combat these factors and pressures in the avionics community, many avionics development and production programs considered today apply to more than one aircraft. However, there are certain programs that emphasize wide applicability that will help to reduce acquisition costs and improve interchangeability and interoperability. Not all avionics programs are suited for standardized programs. Suitable programs present a generally high potential for standardization, utilize mature technology, have an architecture suitable for standardized interfaces, have a multiple-aircraft application, and are

needed in quantities large enough to realize savings in production and support costs. Additionally, these standardization applications must be determined to be cost-effective from a multiple aircraft basis. {8:2}

A viable position on standardization is also necessary in light of our interlocking commitments with our allies and current coproduction agreements regarding the F-16 and other future aircraft.

> In regard to U.S. relations, General Slay expressed the requirement for such an effort with the North Atlantic Treaty Organization: "It's difficult for Bill Perry (William Perry, under Secretary of Defense for research and engineering) to go over to Europe and wave his arms about standardization when we are not doing it..In the future, you will see us specifying more use of standard equipment in RFPs (requests for proposal). {10:20}

In addition to these published statements about avionics standardization in the USAF, the Deputy for Avionics Control has identified the following problems in the avionics standardization arena:

.Overcoming cultural resistance

.Recognizing standardization opportunities

.Determining proper level of standardization

.Avoiding technology stagnation

.Developing companion support/acquisition strategy

.Budget (front end funding)

.Developing a rational standardization policy {2:35}

In summary, the avionics standardization issue will require further clarification by USAF if its benefits are to be obtained in terms of cost savings, operational effectiveness,

and logistics support.

Private Sector Position

Little has been published on the private sector position relating to current USAF initiatives on standardization of avionics acquisitions. An article review in Aviation Week and Space Technology has revealed an attitude in the private sector that the Air Force may have not sufficiently considered the contractor attitudes regarding the usefulness of standardization. "Increased standardization may inhibit competition in the long run through the elimination of competent design teams. It may also contribute to technological obsolescence." {1:65}

Position Summary

The USAF position on this subject appears to be that standardization should be used in the interest of keeping costs within constraints provided by an ever-tightening USAF budget. The USAF policy concerning the effects on the private sector is as yet not clearly established.

The private sector position is basically one that reveals a perceived lack of understanding by the USAF of how standardization policies effect their position. There can be definite short and long-term effects on the private sector that can affect their ability to produce the avionics that the USAF requires.

CHAPTER III

Methodology

Introduction

A description of the universe, the population of interest, and the sampling plan will be presented in this section. The discussion includes a presentation of how the data was collected and how the structured interview guide was developed. Statistical techniques employed, and criteria tests for relating statistical results to research objectives are also covered in this chapter. The final section lists the assumptions and limitations of the study.

Universe

The universe of this study consisted of those companies that have avionics military contracts with the Department of Defense.

Population

The population of interest consisted of avionics contractors with representatives available in Dayton area. The criteria for choosing this area was determined by distance and availability. The contractors in question were within a 60 mile radius of the Dayton area.

Sampling Plan

The sampling plan employed in this research effort was a one-time study due to time, economic, and manpower constraints. The size of the sample was determined by the number of avionics contractors in the aforementioned areas that were available for interviews. Preliminary research

indicated that the total available population would be approximately thirty to forty companies, as such a representative convenience sample was available for data collection.

Each member of the sample was selected on a convenience and judgmental basis with the major constraint being availability. The Deputy for Avionics Control was used to provide the necessary expert opinion in determining representative elements in the sample. "A judgment sample is one where judgment is used to select representative elements from the population or to infer that a sample is representative of the population {6:182}" There are certain biases that can enter in such a sample, but it was the aim of the researchers to control this bias through the use of expert opinion. It is also realized that due to the convenience nature of obtaining some of the data, certain generalizations about the results were limited as convenience samples themselves do not provide any assurance that the sample results are indicative of the population of interest. Despite these limitations, it is believed that significant data was obtained through the use of the data collection instrument. An attitudinal survey by structured interview was utilized to collect a major portion of the data.

Instrument

The structured interview consisted of a series of questions based on a five point Likert-like scale. The instrument contained a series of attitudinal type questions that directed the course of the interview toward the contractors'

areas of expertise and involvement with government contracts. The statements on the Likert-like scale addressed the contractor attitude on the various aspects that standardization may or may not have on his company. The statements that were collected on this summated scale were constructed to meet the following criteria: "(1) each statement was believed to be relevant to the attitude being studied, and (2) each was believed to reflect a favorable or unfavorable position on that attitude {5:249}." The variables that this scale attempted to measure were the dependent variables of contractor reaction and selected avionics acquisition topics, and the independent variables of differing levels of standardization in avionics. The data that was obtained from the Likert-like scale was proposed to be ordinal. "With the Likert scale we can report respondents are more or less favorable to a topic, but we cannot tell how much more or less favorable they are. {5:250}" The data to be analyzed was obtained by direct questioning of the respondents by the interviewers. Two sets of questions were asked to obtain the necessary information for this analysis. The first set of questions dealt with biographical information about the respondent's company and his/her position and individual background. See Appendix A. The second set of questions were asked to determine the contractor's perception of how the various levels of standardization in avionics acquisitions would affect the USAF. These questions are listed in Appendix B. To promote

consistency in the contractors' answers, a listing of pertinent definitions were given him/her to use while responding to the attitudinal survey. These definitions can be found in Appendix C.

Statistical Tests

Nonparametric statistical testing were used for all comparisons and correlations among the subgroups of the sample because they do not require any assumptions about population distribution and also do not require interval level measurement. This decision was made due to the exploratory nature of the research and the fact that our data would not support parametric testing.

Hypothesis Testing

A similar hypothesis test was applied for each application. The null hypothesis was there is no relationship between the independent variables and the dependent variables. The independent variables addressed in the following questions were: Minimum avionics standardization level, current avionics standardization level, and maximum avionics standardization level. Each independent variable was compared to the following dependent variables. The dependent variables were: company position to these levels, contractor perception of USAF equipment availability, contractor perception of USAF acquisition costs, contractor perception of USAF ownership costs, and contractor perception of the effect on technological advancement. Specifically the hypotheses were:

$H_o : P_1 = P_2 = P_3 = P_4 = P_5 = 1/5$ where P_i = the number

of responses in each category of the Lickert-like scale.

H_1: at least one equality exists.

There were 30 contractors that provided answers to the five point Lickert-like scale interview questions. The scale was set up as follows:

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

The following fifteen research hypotheses were tested:

Hypothesis - 1

H_0: There is no relationship between the minimum USAF avionics standardization level and the respondent's company position.

H_1: There is a relationship.

Hypotheis - 2

H_0: The is no relationship between the current USAF avionics standardization level and the respondent's company position.

H_1: There is a relationship.

Hypothesis - 3

H_0: There is no relationship between the maximum USAF avionics standardization level and the respondent's company position.

H_1: There is a relationship.

Hypothesis - 4

H_0: There is no relationship between the minimum USAF avionics standardization level and the contractors' perception of equipment availability to the USAF.

H_1: There is a relationship.

Hypothesis - 5

H_0: There is no relationship between the current USAF avionics standardization level and the contractors' perception of equipment availability to the USAF.

H_1: There is a relationship.

Hypothesis - 6

H_0: There is no relationship between the maximum USAF avionics standardization level and the contractors' perception of equipment availability to the USAF.

H_1: There is a relationship.

Hypothesis - 7

H_0: There is no relationship between the minimum USAF avionics standardization level and the contractors' perception of acquisition costs to the USAF.

H_1: There is a relationship.

Hypothesis - 8

H_0: There is no relationship between the current USAF avionics standardization level and contractors' perception of acquisition costs to the USAF.

H_1: There is a relationship.

Hypothesis - 9

H_0: There is no relationship between the maximum USAF avionics standardization level and contractors' perception of acquisition costs to the USAF.

H_1: There is a relationship.

Hypothesis - 10

H_0: There is no relationship between minimum USAF avionics standardization and contractors' perception of ownership cost to USAF.

H_1: There is a relationship.

Hypothesis - 11

H_0: There is no relationship between the current USAF avionics standardization level and contractors' perception of ownership cost to the USAF.

H_1: There is a relationship.

Hypothesis - 12

H_0: There is no relationship between the maximum USAF avionics standardization level and contractors' perception of ownership cost to the USAF.

H_1: There is a relationship.

Hypothesis - 13

H_0: There is a relationship between the minimum USAF avionics standardization level and contractors' perception of technological advancement.

H_1: There is a relationship.

Hypothesis - 14

H_0: There is no relationship between the current USAF

avionics standardization level and contractors' perception of technological advancement.

H_1: There is a relationship.

Hypothesis - 15

H_0: There is no relationship between the maximum USAF avionics standardization level and contractors' perception of technological advancement.

H_1: There is a relationship.

Testing Procedure

The testing procedure that was used in this analysis was the Kolmogorov-Smirnov (K-S) Test. The K-S is the test choice when the data are at least ordinal, and the research situation calls for a comparison of an observed sample distribution with a theoretical distribution. Under these conditions the K-S one-sample test is more powerful than the chi-square test and can be used for very small samples when the chi-square test cannot. The K-S is a test of goodness of fit in which we specify the cumulative frequency distribution which would occur under the theoretical distribution and compare that with the observed cumulative frequency distribution. The theoretical distribution represents our expectations under H_0. We determine the point of greatest divergency between the observed and the theoretical distributions and identify this value as D (maximum deviation). From a table of critical values for D we determine whether such a large divergence is likely on the basis of random sampling variations from the theoretical distribution. The value of D is calculated as follows:

$$D = \text{maximum } F_o(C) - F_t(X)$$

in which $F_o(X)$ = the observed cumulative frequency distribution of a random sample of N observations. Where X is any possible score, $F_o(X) = K/N$, where K equals the number of observations equal to or less than X. $F_t(X)$ = the theoretical frequency distribution specified under H_o. {9:385}

The SPSS Release 7 NPAR TEST procedure was used to apply the K-S test to the data. The nonparametric test in SPSS for

K-S is a goodness fit type of test. The routine tests whether the observed data could reasonably have come from a theoretical distribution specified by the user. For our research, the test was to determine if the observed data was uniformly distributed.

> The cumulative distribution functions for the observed data and the theoretical distribution are computed, as well as the difference between them. The Kolmogorov-Smirnov Z is determined from the largest difference (positive or negative). The larger the value of Z, the less likely it is that the observed and theoretical distributions are the same.
>
> The statistics provided included: number of cases, sample mean, standard deviation, minimum and maximum values as appropriate, the maximum positive, negative, and absolute differences between the theoretical and observed cumulative distribution functions: The Kolmogorov-Smirnov Z; and the two-tailed probability levels of Z based on the Smirnov formula using three terms. {8:74}

Assumptions and Limitations

The following assumptions are made:

1. Ordinal level measurement of meaningful, unidimensional, attitudinal variables will be attained.

2. Responses of the interviewees provide honest, factual answers based on their knowledge, opinions and perceptions.

The following limitations are present:

1. The extent as to how far the results can be generalized beyond the population of contractors interviewed.

2. The results generated from the small sample size of contractors interviewed could be affected by an increase in the sample size.

CHAPTER IV

Data Analysis and Findings

This chapter presents the results of the analysis of the data collected from the structured interview and the responses to the open-ended questions to satisfy the research objectives presented in Chapter One. This chapter will discuss the findings of the research in two basic sections. The first section will be a discussion of the results of the data obtained by the structured interviews. The second section will cover the findings obtained from the contractor's responses to our open-ended questions.

Data Analysis

The actual sample size that was obtained for the structured interview was thirty avionics contracting representatives. The individuals who responded to the survey questions had a mean of twenty-seven years of experience in the avionics acquisition field. Twenty-three respondents had an engineering background and are now marketing representatives for their various companies and corporations.

The actual responses to each question were plotted on histograms. These histograms are located at the end of the Data Analysis section. While specific conclusions about these answers are not possible due to the nonparametric nature of the data, there are certain inferences that can be made concerning how these particular answers can be interpreted. These comments are stated in each of the five hypotheses.

These five hypothesis areas are company position, equipment availability, acquisition cost, ownership cost and technological advancement.

Testing Procedure

The Kolmogorov-Smirnov test was the major analytical tool applied to the data for the structured interview responses. The testing process was as follows:

1. Hypothesis Test. H_0: There is no relationship between the various levels of the independent variable and each of the five dependent variables.

   H_1: There is a relationship between the various levels of the independent variable and each of the five dependent variables.

The various levels of the independent variable are minimum, current, and maximum levels of standardization. The five dependent variables are company position, equipment availability, acquisition cost, ownership cost, and technological advancement.

2. Statistical Test. The Kolmogorov-Smirnov one-sample test was used because the data was ordinally measured and a comparison of an observed distribution with a theoretical one was required.

3. Significance Level. $\alpha = .05$, $N = 30$

4. This value was determined by SPSS Release 7 NPAR test standard program.

Table 1 - SPSS Release 7 NPAR Test

Kolmogorov-Smirnov Calculated Values for the one-sided test by Structured Interview Questions:

1 - 2.008	6 - 2.373	11 - 2.921
2 - 2.191	7 - 1.643	12 - 2.191
3 - 2.191	8 - 2.556	13 - 1.826
4 - 1.826	9 - 1.552	14 - 3.834
5 - 4.199	10 - 4.382	15 - 3.651

5. Critical Test Value. A Kolmogorov-Smirnov table of critical values of D in the Kolmogorov-Smirnov one-sample test was used to obtain a value at the level of = .05. This critical value was determined to be .24.

6. Decision. Since the calculated value in all 15 cases was significantly greater than the critical value, it was determined that the null hypothesis must be rejected. A relationship does exist between our independent and dependent variables.

Structured Interview Responses

The responses to the structured interviews will be analyzed in light of the five aforementioned major topic areas. Each topic area required three responses based on how the various standardization levels would impact the particular topic area.

Company Positions

Table 2 - Responses to Structured Interview Questions Concerning Company Position

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Maximum Level	2	11	5	12	0
Current Level	0	7	2	20	1
Minimum Level	0	6	2	21	1

The first area concerned the company's position of how the various standardization levels would influence their operations. The data revealed that, in general, the contractors agreed that the current and minimum USAF standardization levels are consistent with their particular company's position. The response to the maximum level criteria reveals no strong position either way. The statistical test showed that the overall responses were in no way uniformly distributed and that a relationship between the three standardization levels and their company's positions can be implied. Similar responses were noted in this area from both the large and small contractors. Size was determined from the annual sales figures obtained from each interviewee. Basically, it appears that in this area, the contractors are relatively satisfied with the current standardization level or are inclined to feel that less standardization would be more beneficial from their viewpoint.

While a significant conclusion about this area cannot be supported by the level of data, it appears that the contractors will accept minimum and current standardization levels, but show no overall tendency at the maximum level.

Equipment Availability

Table 3 - Responses to Structured Interview Questions Concerning Equipment Availability

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Maximum Level	0	11	6	13	0
Current Level	1	19	5	5	0
Minimum Level	0	23	3	2	2

The second area that was covered by the structured interview concerned the effect that the various standardization levels would have on equipment availability. The statistical test again revealed that the response data was not uniformly distributed. As is evidenced by the histograms of these questions, it appears that the contractors tend to disagree that the current and minimum standardization levels will decrease equipment availability to the USAF. However, if standardization is taken to the maximum level, there does not appear to be a significant opinion regarding this question either way. It appears that the USAF will continue to have equipment available from the contractors as long as minimum or current levels of standardization are used. The effect of a maximum level cannot be ascertained.

Acquisition Cost

Table 4 - Responses to Structured Interview Questions Concerning Acquisition Cost

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Maximum Level	0	12	2	11	5
Current Level	1	18	3	8	0
Minimum Level	1	13	2	14	0

The third area of analysis deals with whether a difference in the various levels of standardization will increase acquisition costs to the USAF. In testing the data, once again it was determined that the responses were not uniformly distributed. The respondents tended to disagree that the current standardization level will increase acquisition costs. This reflected growing evidence regarding the respondents' concern with costs. A change from the current level to the minimum level revealed a lack of common agreement as to how acquisition costs would be affected. However, in the area of maximum standardization, the respondents' did show a more pronounced agreement that this level will increase acquisition costs.

Ownership Cost

Table 5 - Responses to Structured Interview Questions Concerning Ownership Cost

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Maximum Level	1	21	3	5	0
Current Level	0	24	3	3	0
Minimum Level	1	10	3	16	0

The effect that various levels of standardization have on increasing ownership costs was the fourth major area addressed in the structured interview. The data was definitely not uniformly distributed. Actually, the reponses to this area revealed a considerable disagreement by a large number of the respondents that current standardization levels will increase ownership costs. A more even split of opinion can be seen in the histogram related to the response concerning the effect that minimum standardization levels will have. This diversity of opinion was not evident when the respondents answered the question in light of maximum standardization. In this area, there was strong disagreement that ownership costs would increase at this level.

Technological Advancement

Table 6 - Responses to Structured Interview Questions Concerning Technological Advancement

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Maximum Level	1	5	4	20	0
Current Level	1	13	6	10	0
Minimum Level	0	21	4	5	0

The fifth and final area addressed the impact that the various standardization levels have on technological advancement. Once again the Kolmogorov-Smirnov test revealed non-uniformity. The histogram displayed a fairly even split of responses regarding the impact of current standardization level. The significant areas of response centered in the areas of minimum and maximum levels. There was strong disagreement that the minimum standardization level would decrease technological advancement. Of equal significance was the strong agreement that increasing standardization to the maximum level would decrease technological advancement. These responses reflected growing evidence that this area could be one of considerable concern to the contractors.

Summary

While the respondents' replies to the structured interview revealed that a relationship does exist between the independent and dependent variables in all fifteen questions,

the more important results were obtained from the contractors' responses to the open-end questions. These responses are the contractors' own opinion and will be presented in the next section.

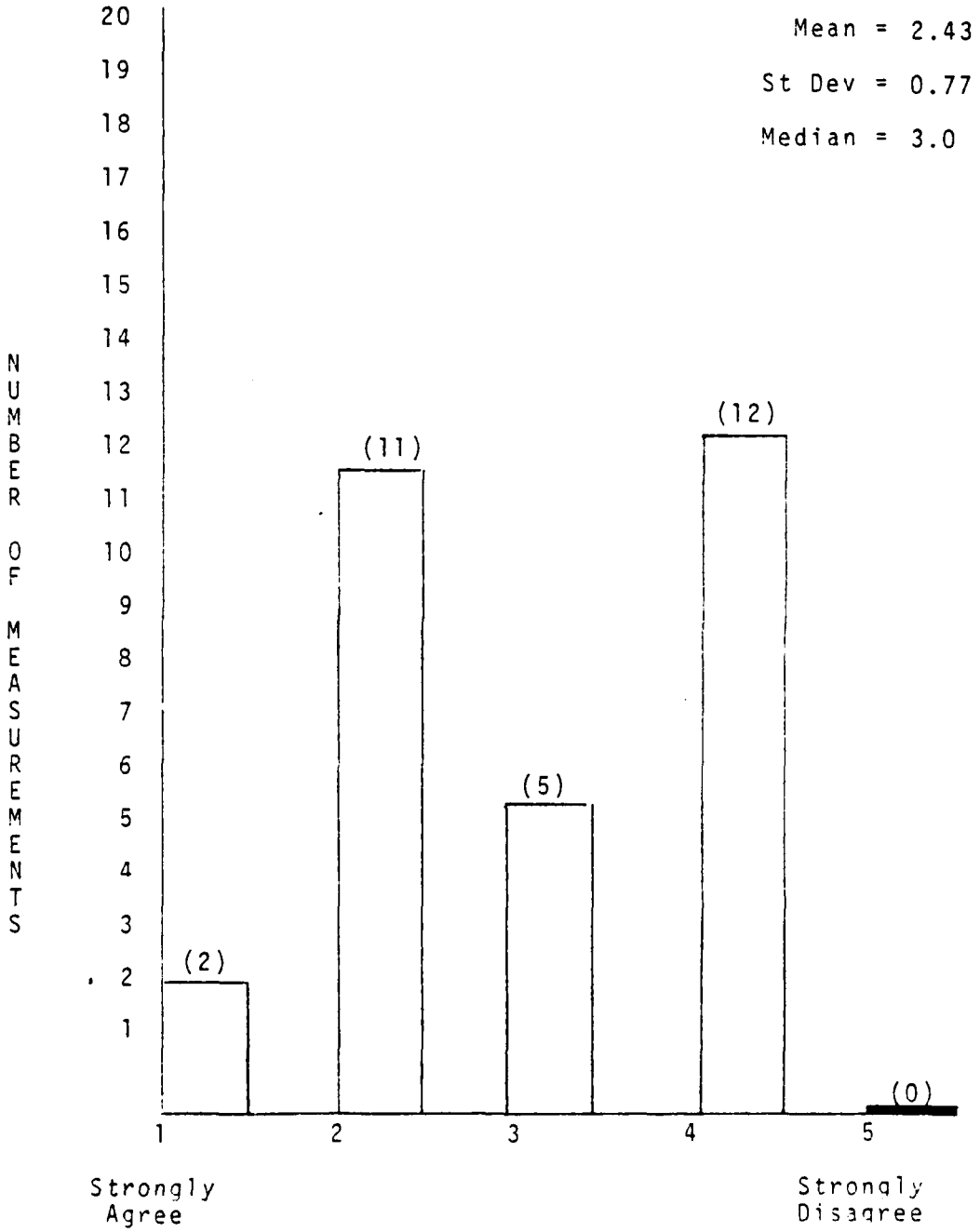

Fig. 1. Histogram of Maximum Avionics Standardization Level and Company Position

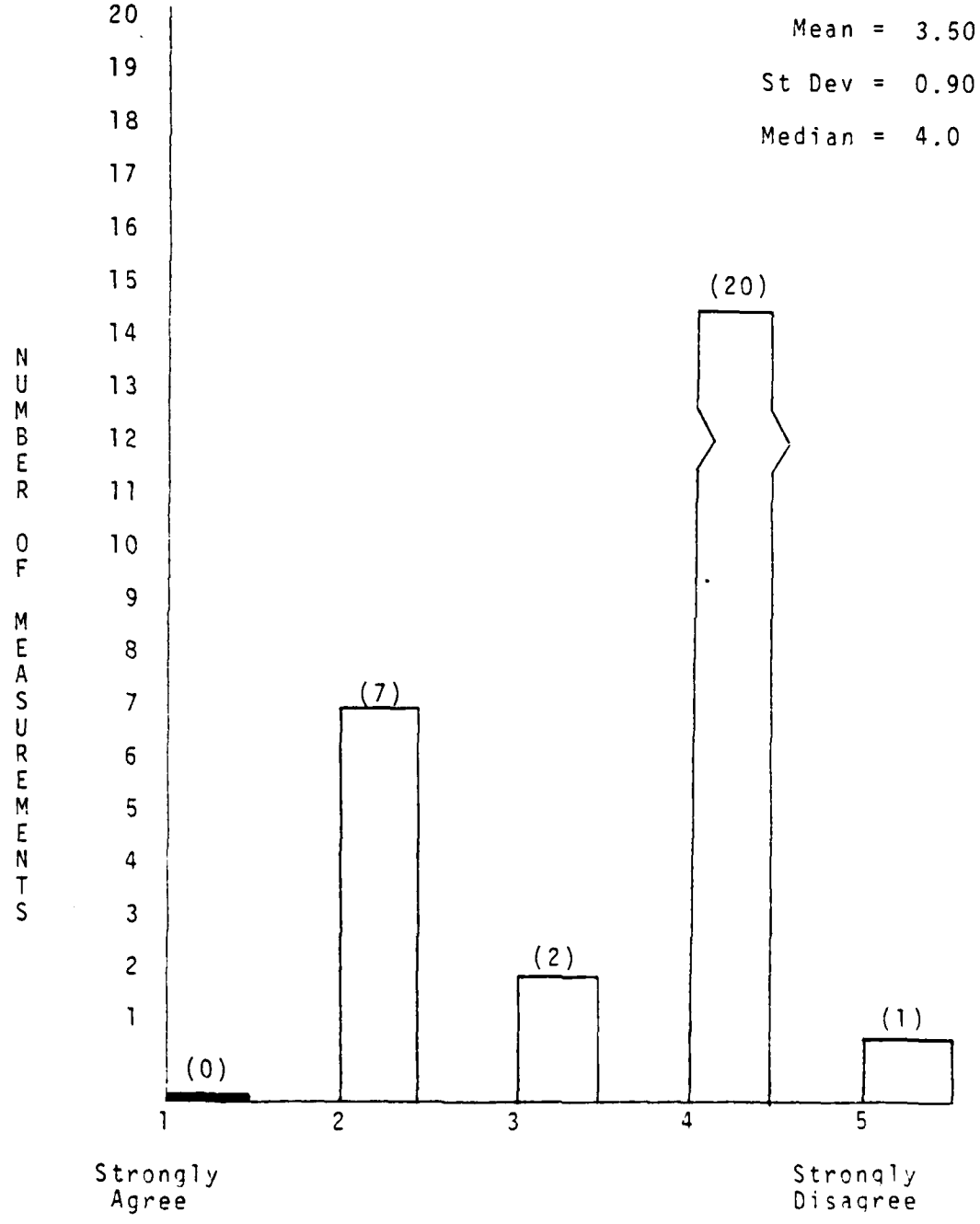

Fig. 2. Histogram of Current Avionics Standardization Level and Company Position

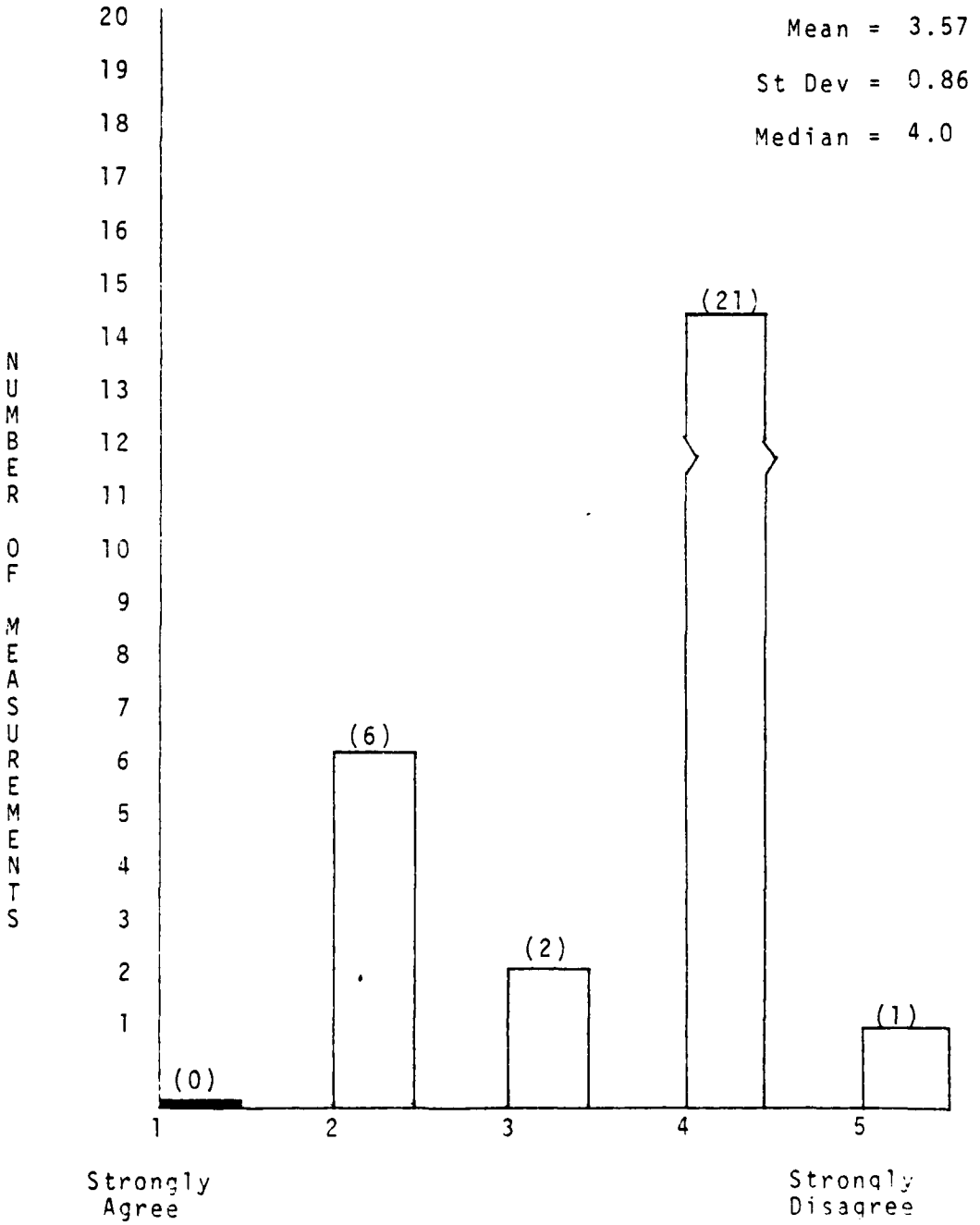

Fig. 3, Histogram of Minimum Avionics Standardization Level and Company Position

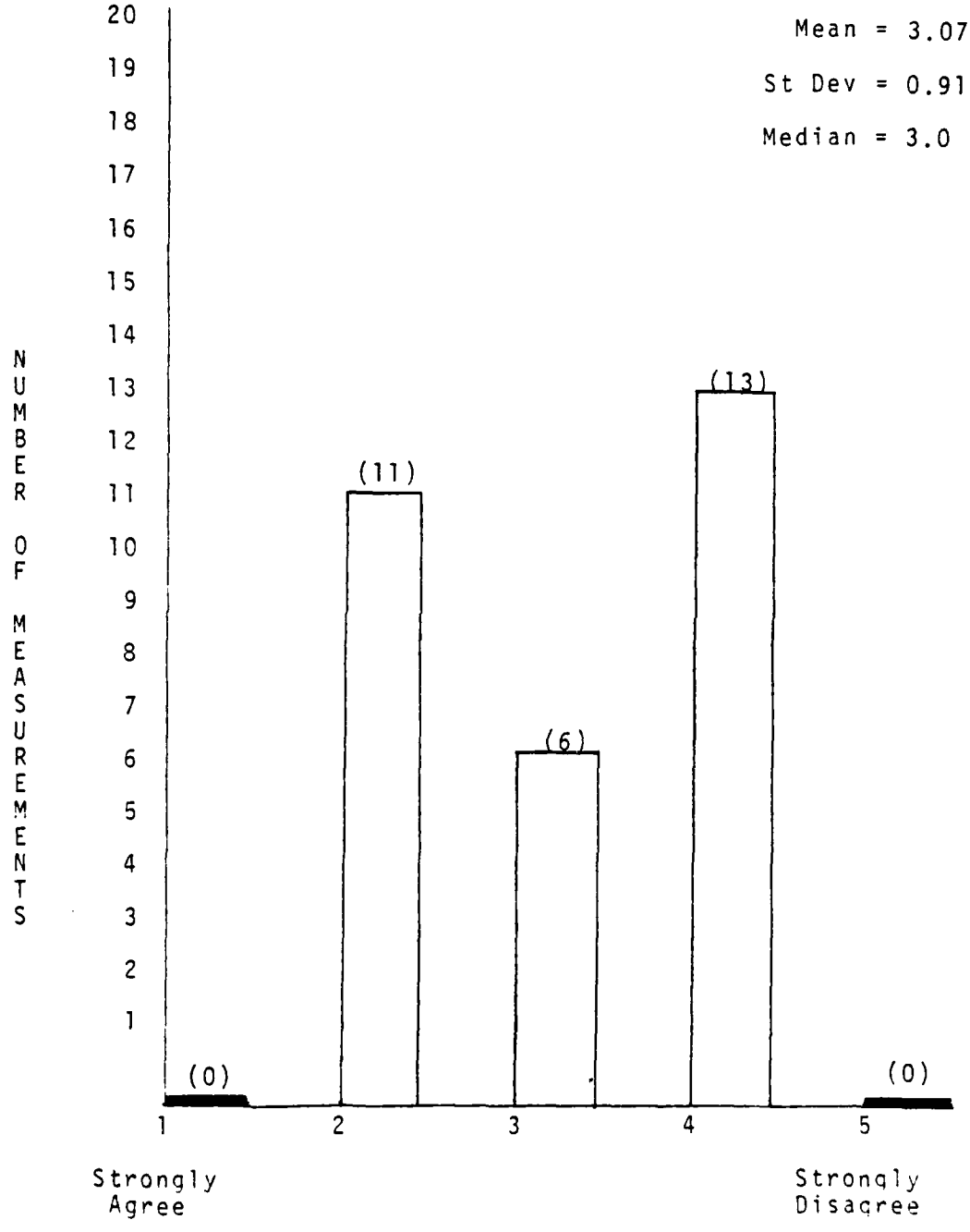

Fig. 4. Histogram of Maximum Avionics Standardization Level and Equipment Availability

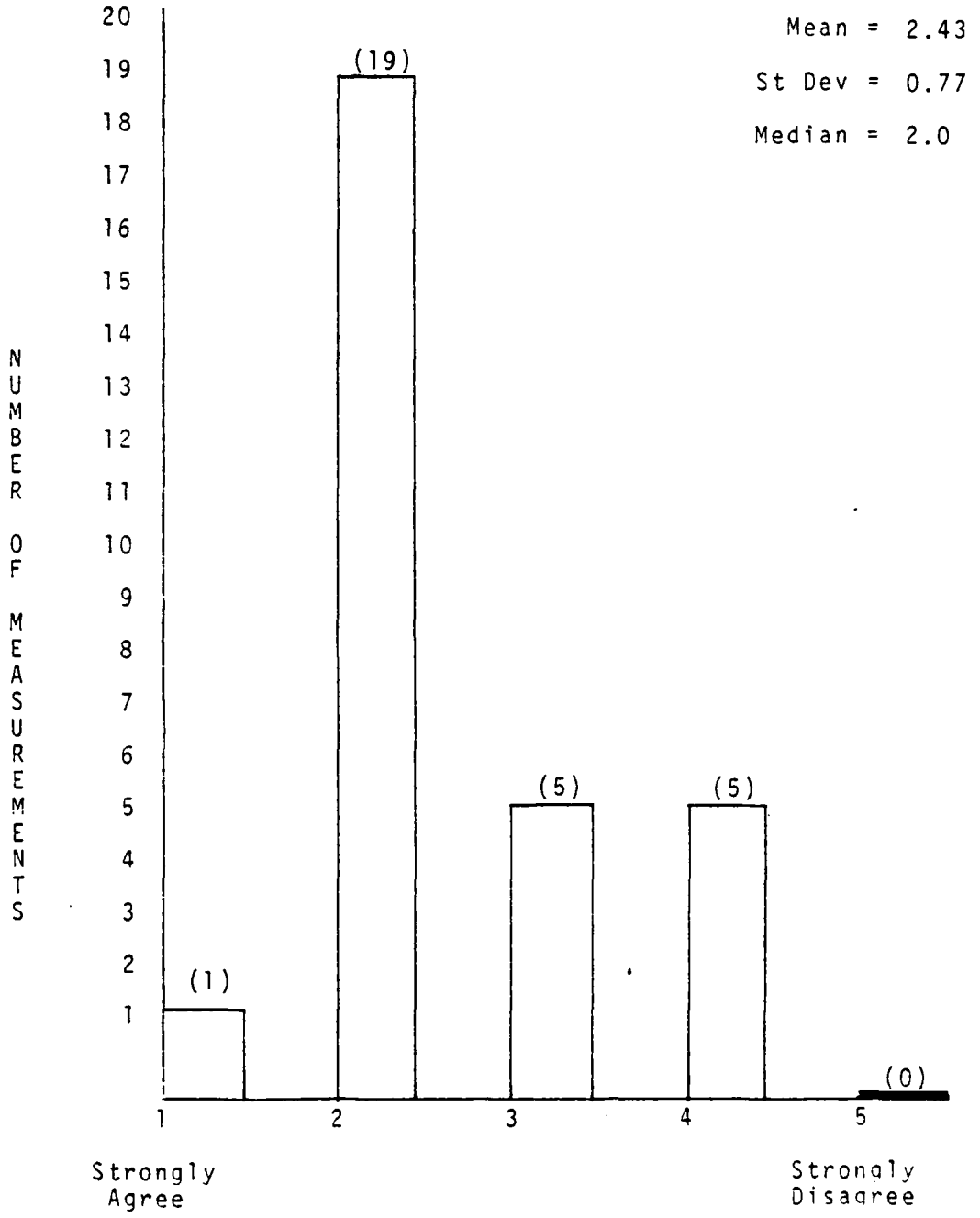

Fig. 5. Histogram of Current Avionics Standardization Level and Equipment Availability

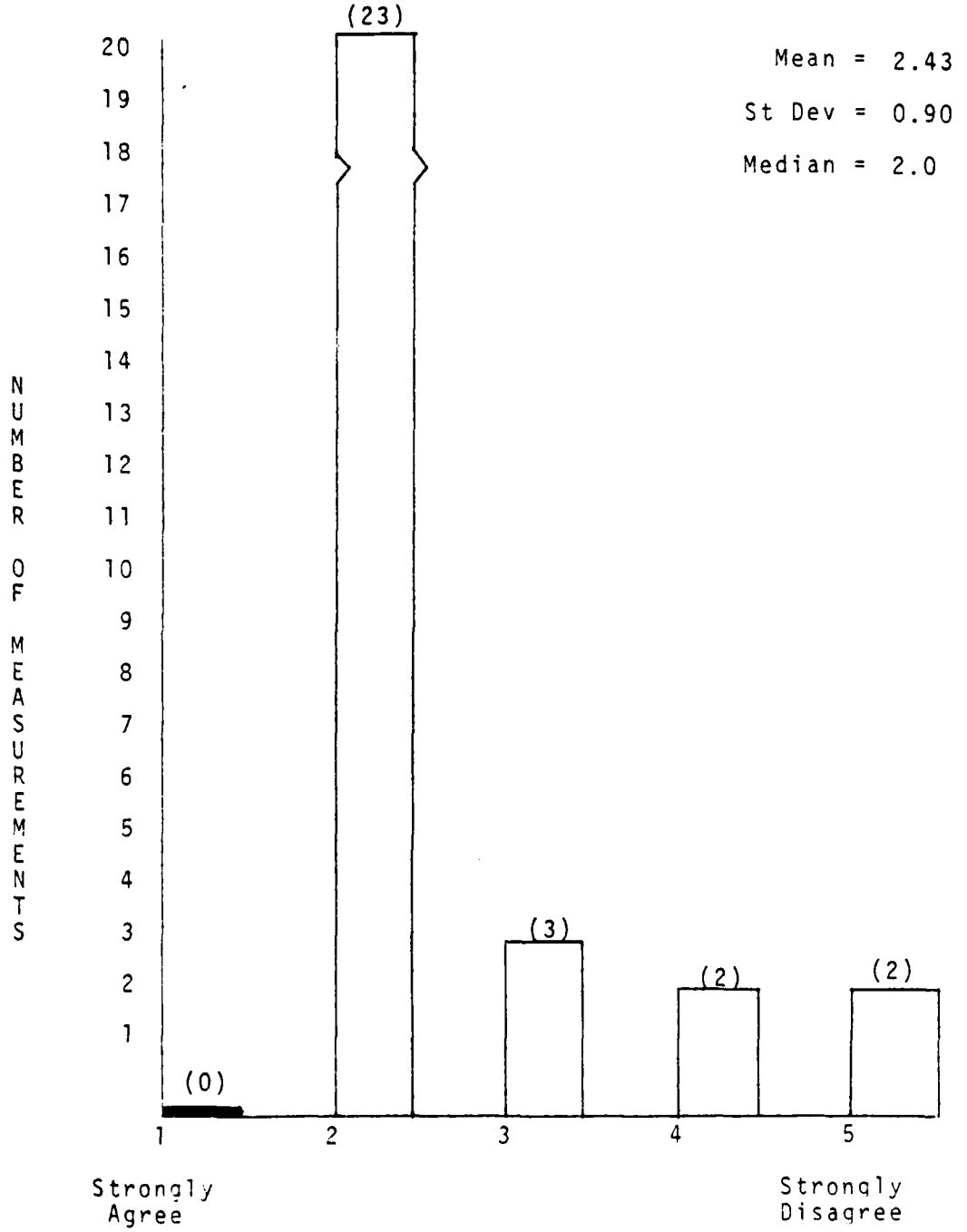

Fig. 6. Histogram of Minimum Avionics Standardization and Equipment Availability

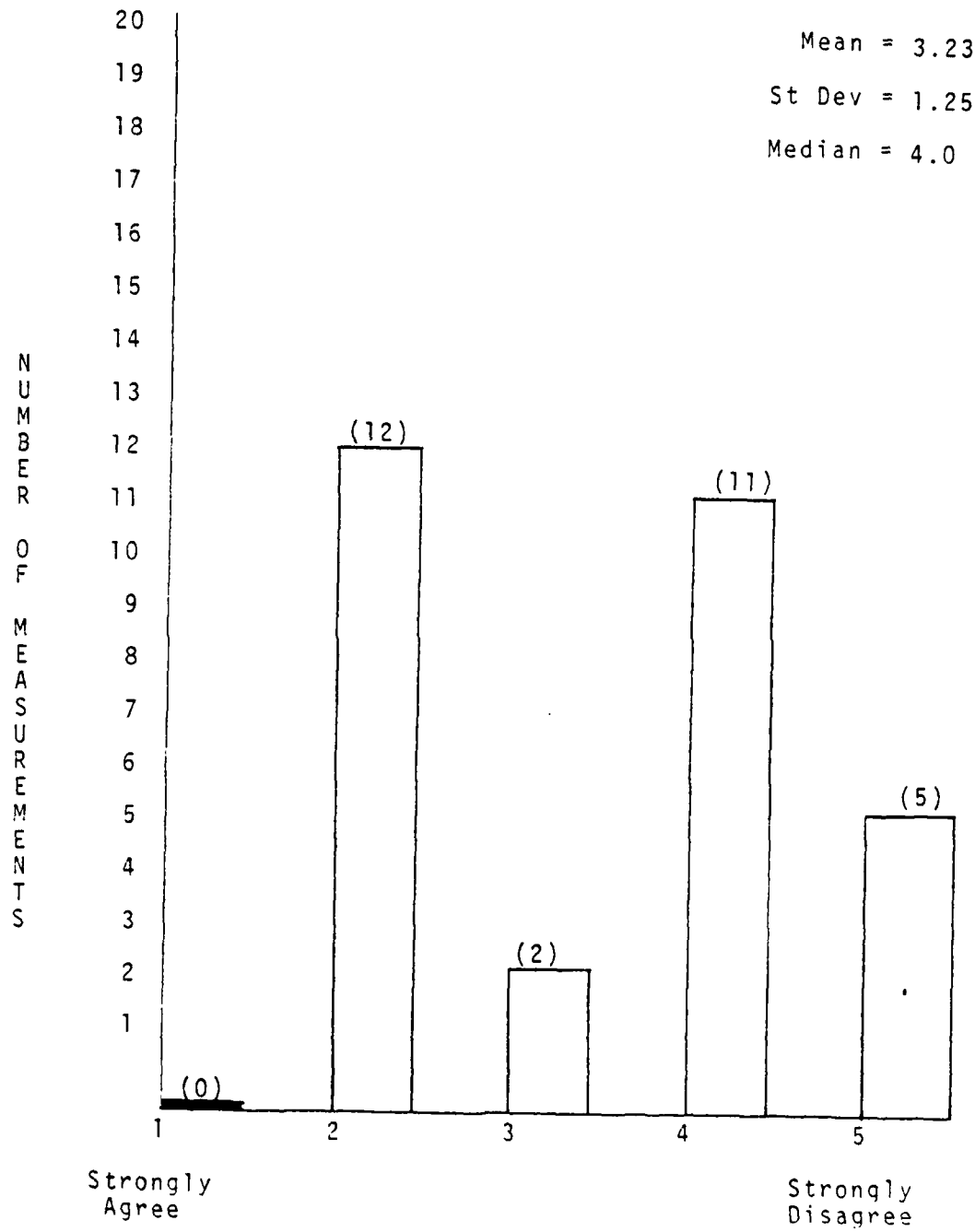

Fig. 7. Histogram of Maximum Avionics Standardization Level and Acquisition Costs

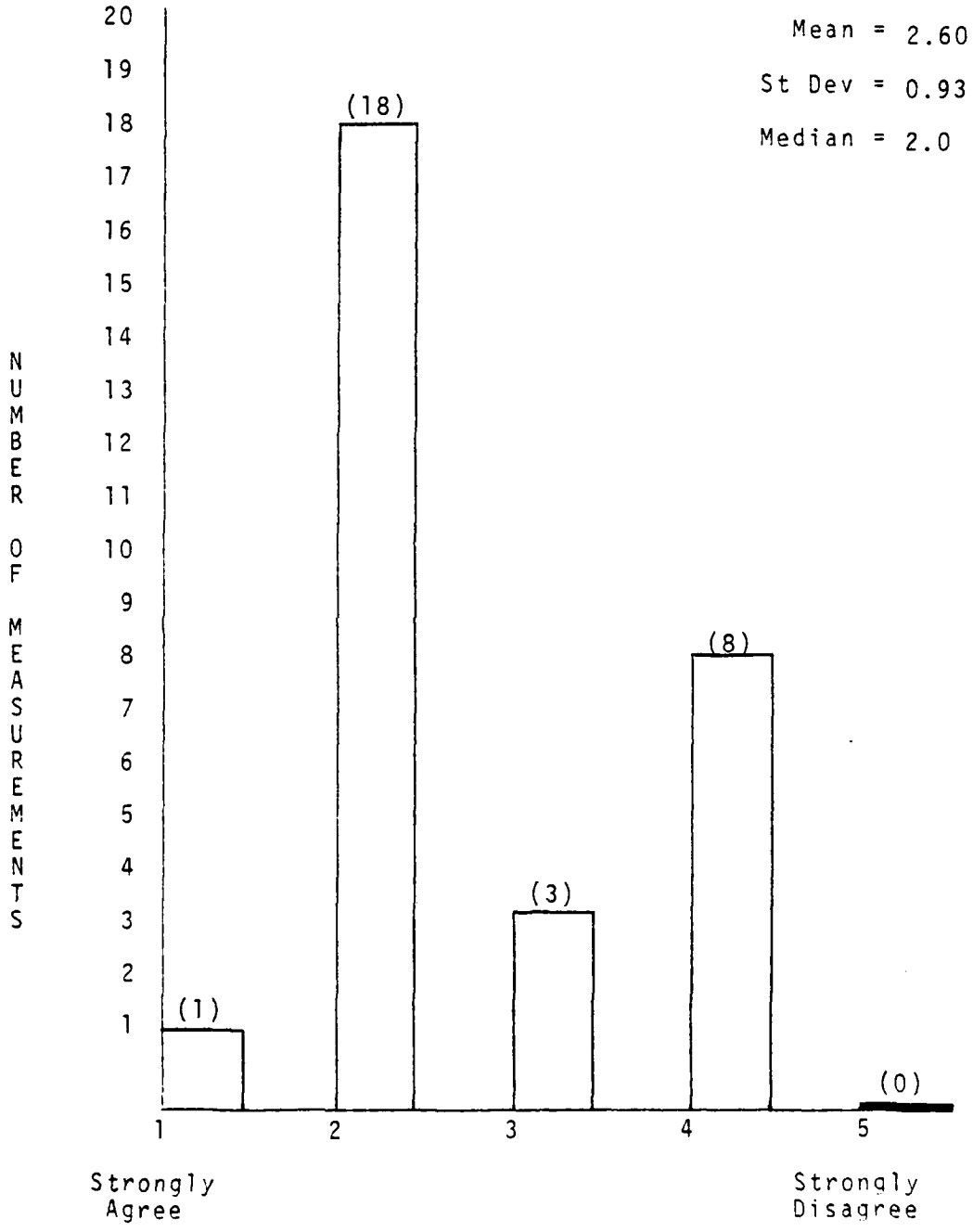

Fig. 8. Histogram of Current Avionics Standardization Level and Acquisition Costs

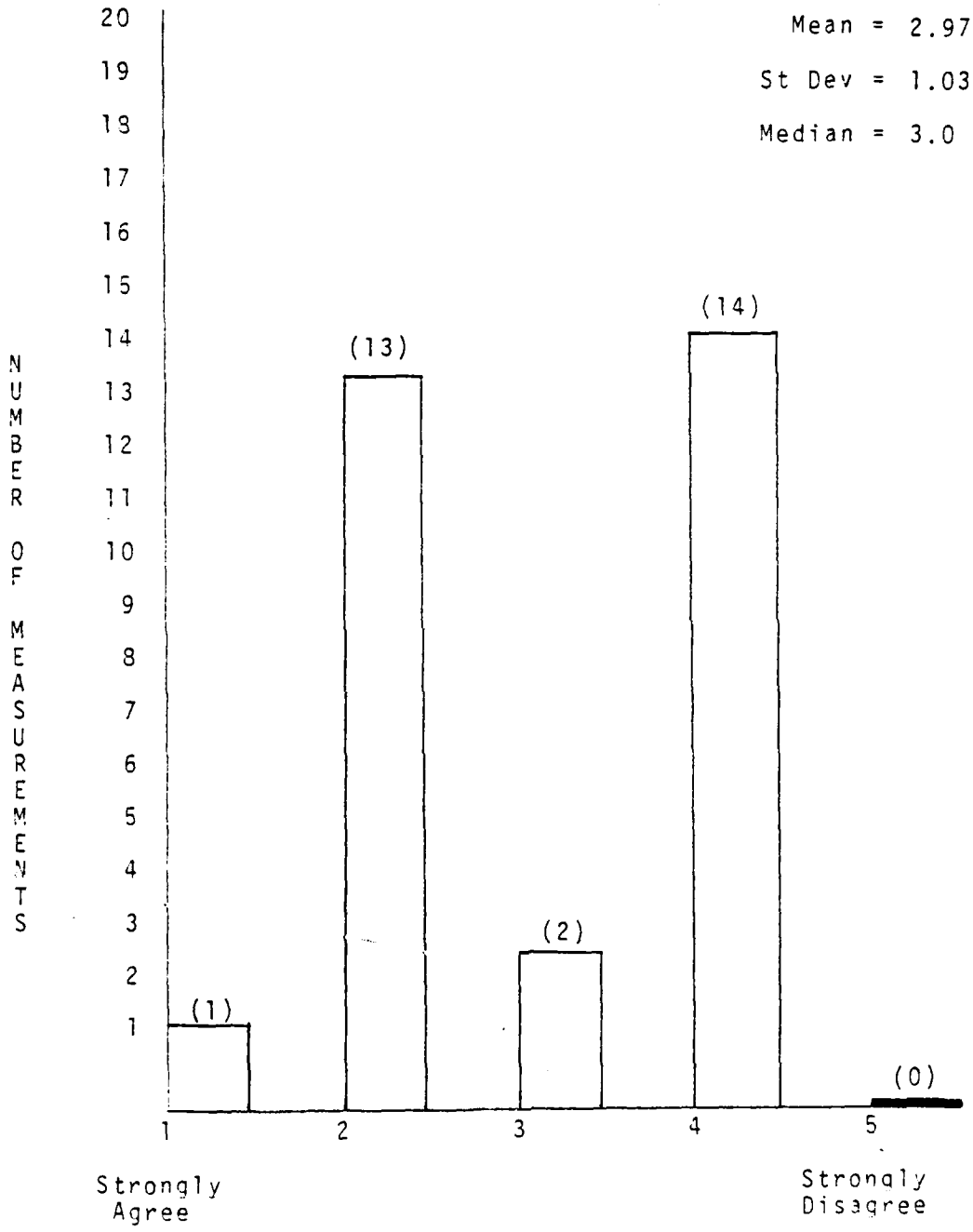

Fig. 9. Histogram of Minimum Avionics Standardization Level and Acquisition Costs

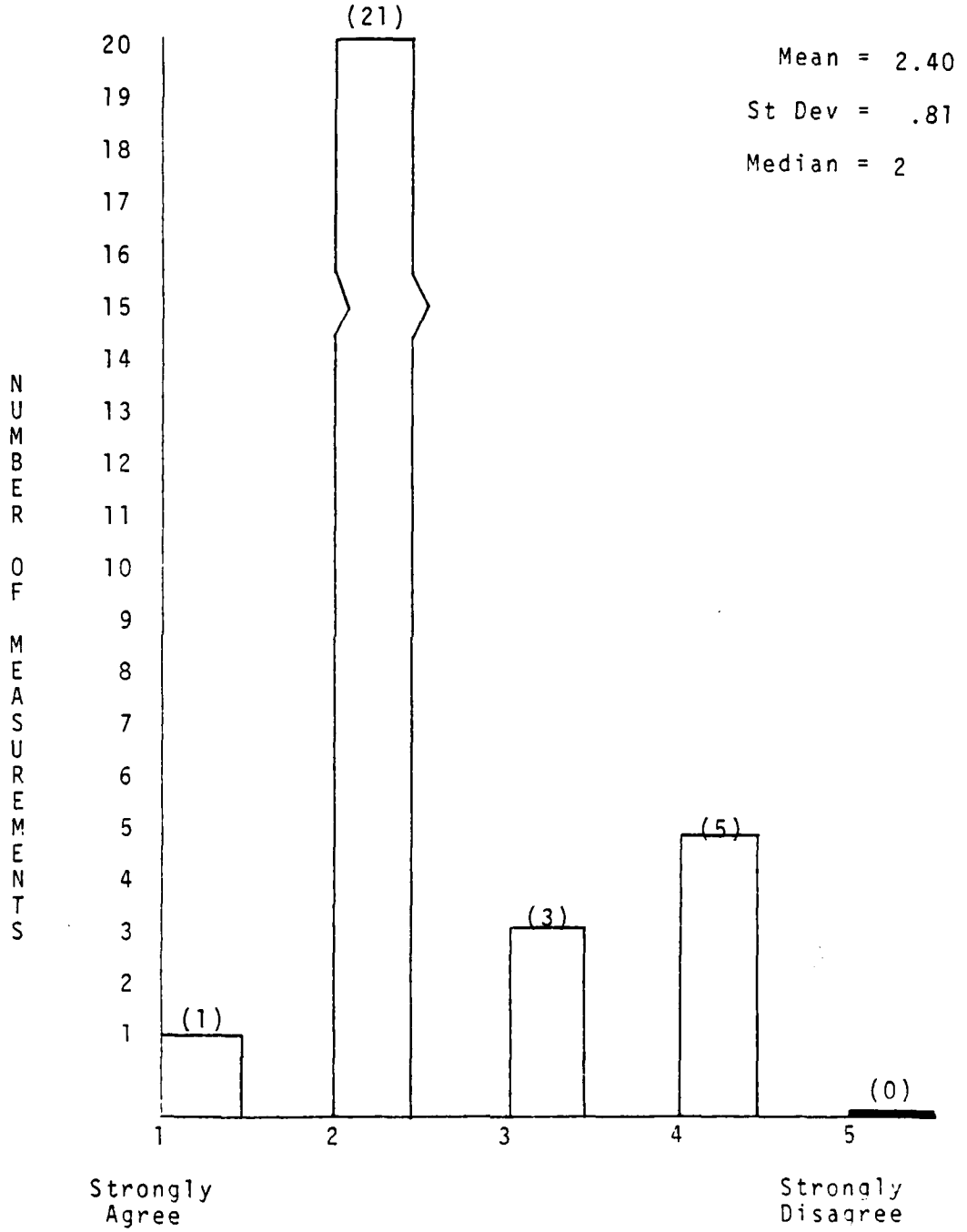

Fig. 10. Histogram of Maximum Avionics Standardization Level and Ownership Costs

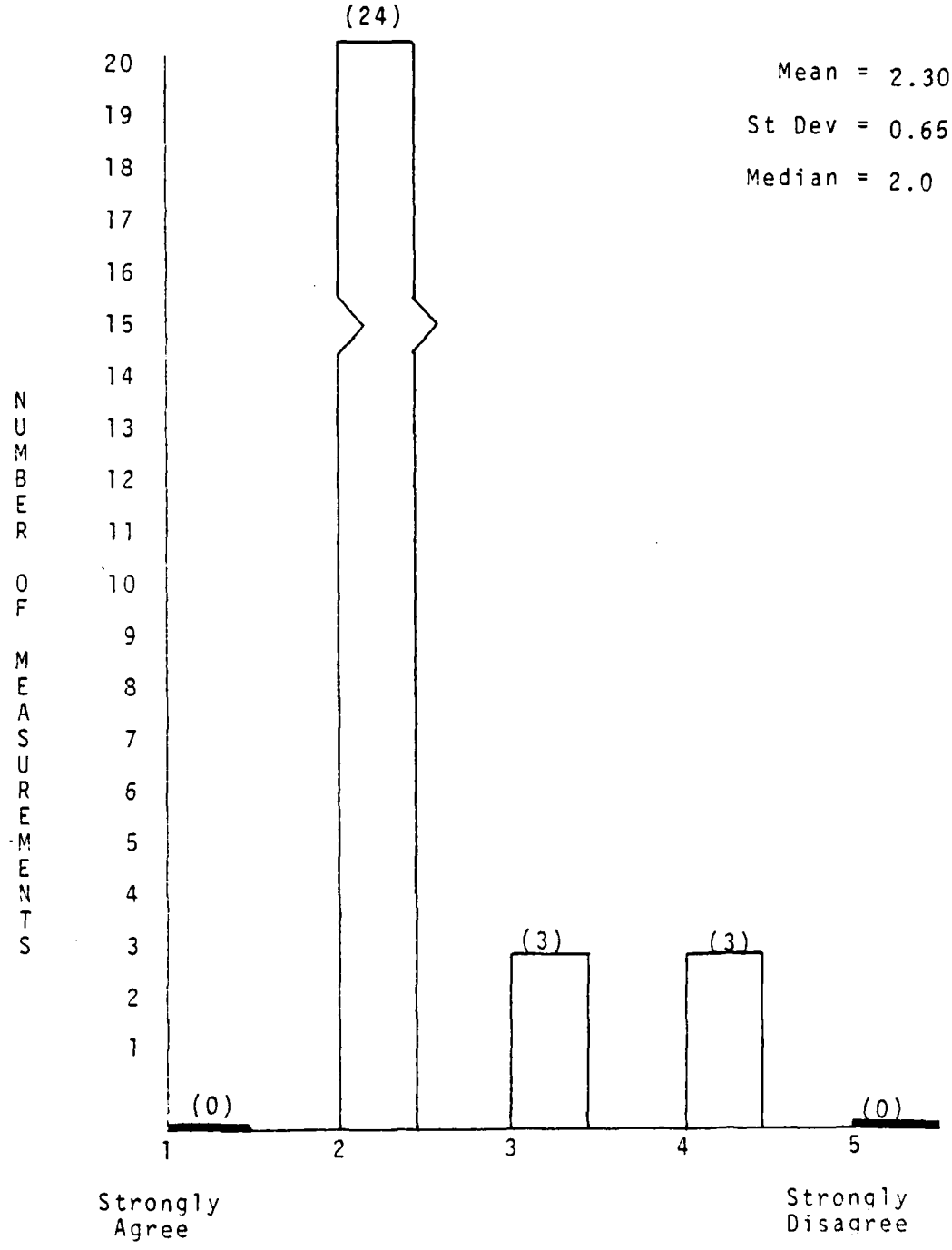

Fig. 11. Histogram of Current Avionics Standardization Level and Ownership Costs

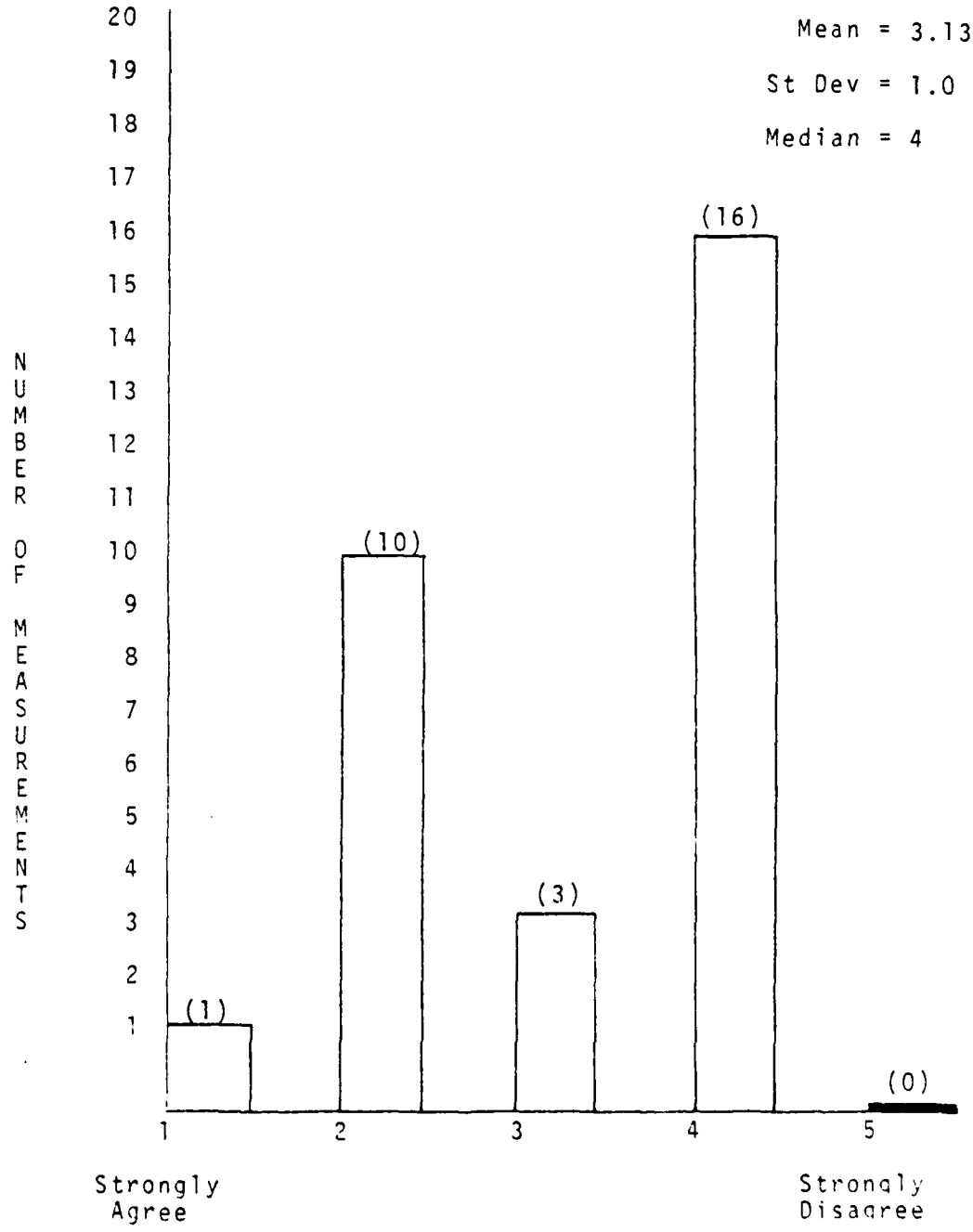

Fig. 12. Histogram of Minimum Avionics Standardization Level and Ownership Costs

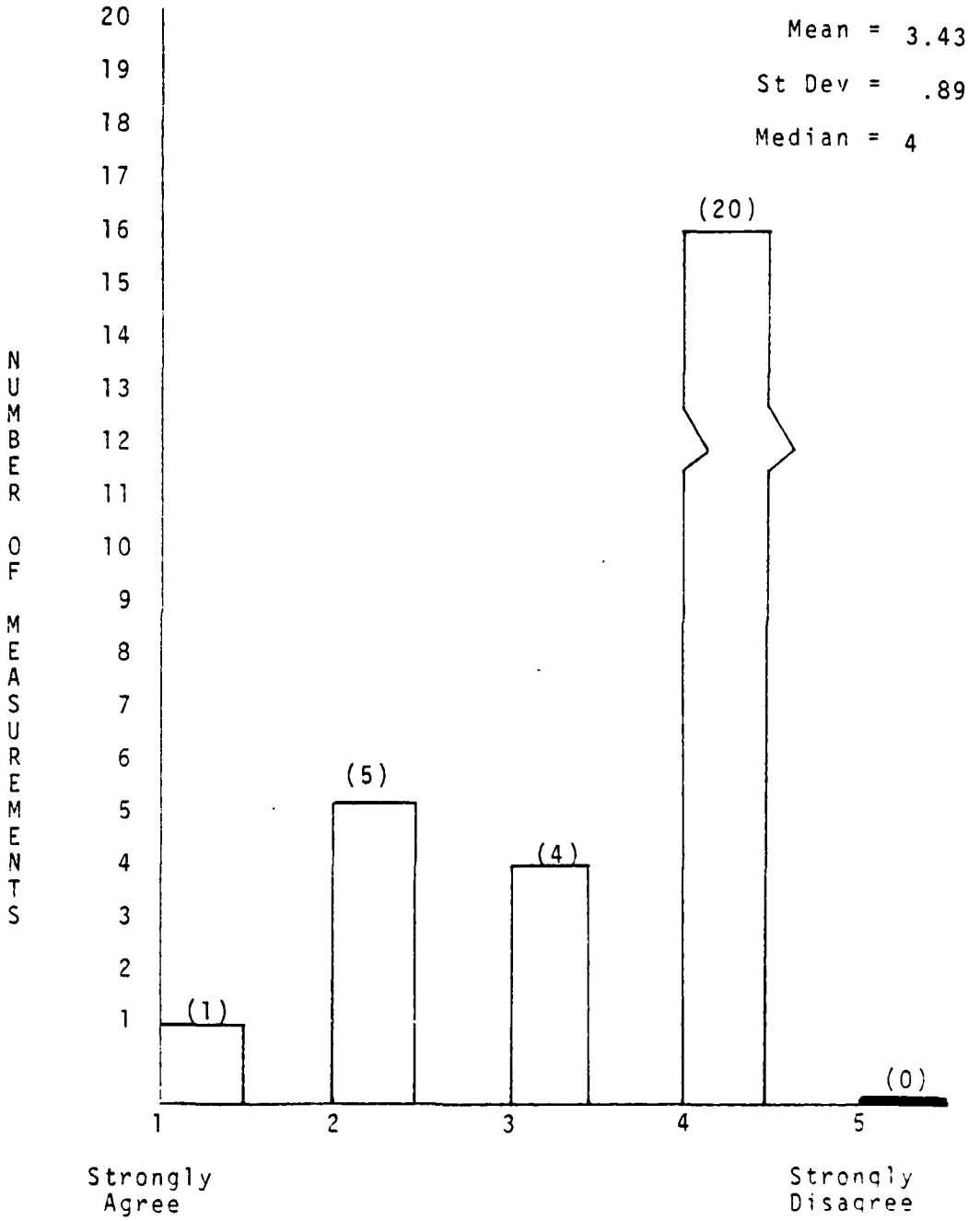

Fig. 13. Histogram of Maximum Avionics Standardization Level and Technological Advancement

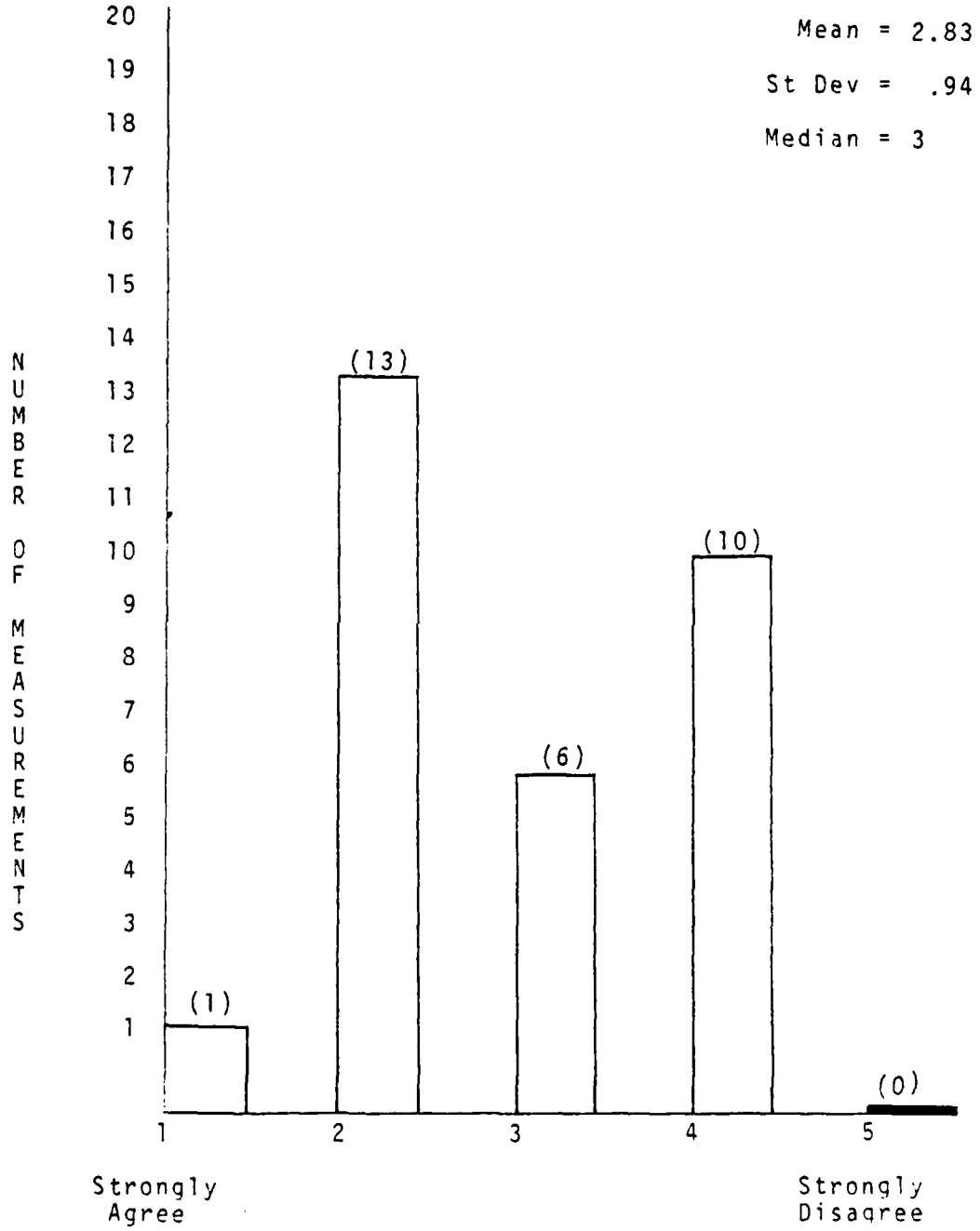

Fig. 14. Histogram of Current Avionics Standardization Level and Technological Advancements

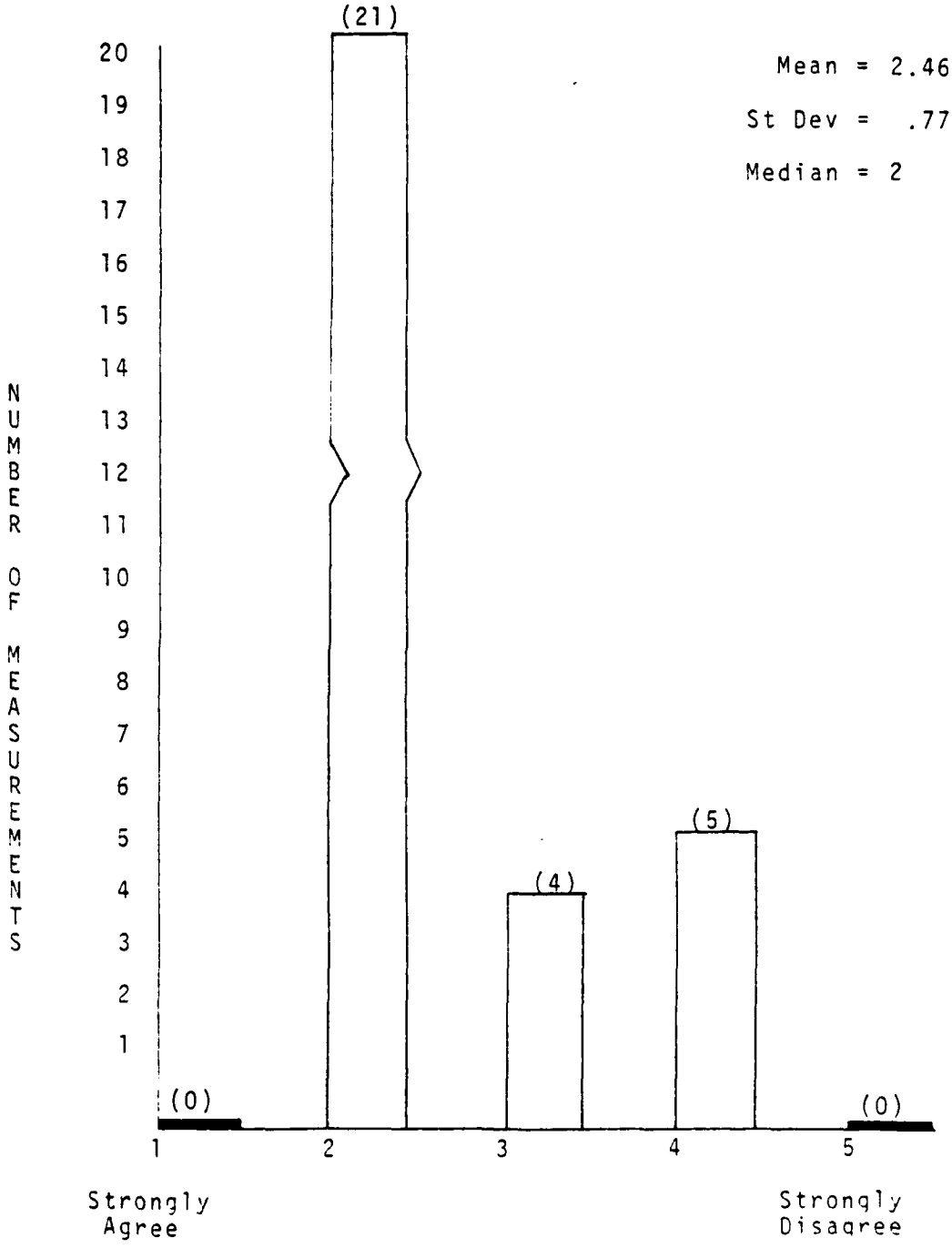

Fig. 15. Histogram of Minimum Avionics Standardization Level and Technological Advancement

FINDINGS

Thirteen firms responded to the open-end questions concerning avionics standardization issues. These issues included how avionics standardization levels would affect their company's market position in relation to avionics sales to USAF, equipment availability to USAF, acquisition cost to USAF, ownership cost to USAF, and technological advancement in avionics research and development. In addition, the respondents were asked to identify the standardization level that they felt would be the most appropriate.

GENERAL

The responses to the open-end questions will be presented by individual questions with a special concerns section at the end of this chapter. Each question will be discussed from the standpoint of a majority opinion and a minority opinion of the responses received. These opinions respond to the open-ended question only, and were not obtained at the time of the structured interview. As a result, the responses to the open-ended questions and the data from the structured interviews may not agree.

Additionally, the respondents to these open-ended questions were assured that their replies would be held in the strictest confidence. As a result of this assurance, the majority of the statements quoted in the findings

section will remain anonymous. Whenever possible, specific permission was obtained to quote and identify a respondent, and as a result, these respondents will be identified. If the requirement exists to specifically identify a particular anonymous quote requests may be forwarded to the authors of this thesis or the thesis advisors identified in front of this report. Permission to release the identity will then be requested from the respondent. If permission is not granted, the name will not be released.

Lastly, the authors feel that these replies to the open-ended questions are more significant in determining the contractors' position on avionics standardization than the results of the structural interview. These responses represent contractor's actual positions on issues critical to USAF in the area of avionics standardizations, and as such, should be weighed more heavily than the answers to a limited structured interview.

Effect on Company's Market Position

Majority Opinion

The effect of various avionics standardization initiatives by the USAF is of prime importance to the contractor community. Their company's position in avionics sales is directly related to their acceptance or rejection of these initiatives. If these companies do not feel that they can adequately compete in satisfying these initiatives, they will not respond to USAF Invitations for Bids or Request for Proposals. Non-response by the avionics

contractor community will result in lack of vitally needed avionics components for the USAF. The general consensus of the respondents to the question, "How will these avionics standardization levels affect your company's market position and avionics acquisitions to the USAF is as follows:

> It (standardization) will have a tendency to establish a trend toward specific equipment specialization and will force management to be highly selective in their choice of programs to be pursued and technologies to be funded under IR&D. Primarily as a system/major subsystem avionics hardware and integration company, avionics minimum and current policy standardization should not greatly impact our company's market position. Maximum standardization may have a tendency to limit competitive subsystem suppliers and equipment lead time for major avionics subsystem procurements.
>
> I believe that USAF avionics standardization, at any of the indicated levels, will not significantly affect our market position or total sales to the Air Force, but will...tend to drive us further toward specialization as opposed to broadening our product line.

These two comments which were made by major avionics contractors, are representative of the majority opinion of the contractors who replied to the first open-ended question on the effect of standardization on their company's market position. The proposed minimum and current standardization levels would not adversely affect their company. Concern was voiced about the possible consequences of implementation of the maximum level. According to the respondents, this level could result in limiting USAF suppliers and adversely affecting lead times for major weapon systems acquisitions. In addition, these contractors stated ancillary effects would be caused by avionics standardization.

Standardization will cause specialization in product development due to funding limitations and management direction. This specialization will result in a limitation of the product lines available from avionics contractors. This limitation could result in a smaller number of available contractors for the development and production of critical avionics components. As a result of the possible shrinking market size, our avionics technology base could be reduced and the overall cost of avionics acquisition could increase. The USAF market position would then be altered.

> It is clear from the foregoing that neither the USAF or___would benefit from a maximum level of standardization. As a result of such a policy, it is believed that market position and associated avionics acquisitions would be adversely affected to a significant degree. On the other hand, there is no objection to the employment of avionics equipment common to other aircraft when the penalties are not significant and valid cost savings can be shown for the cost of ownership of this common equipment. This would support the viability of a minimum avionics standardization level and the current avionics standardization policy if these are judiciously applied.

In conclusion, the majority of the respondents felt avionics standardization must be rationally employed. The proposed minimum and current levels could be easily adapted to reflect this rational approach. The maximum level, on the other hand, could not be adapted or judiciously applied.

Minority Opinion

A few of the respondents to this question felt that the various levels of avionics standardization would have an adverse effect on their operations.

> Avionics standardization levels have already had a negative affect..Avionics standardization will require the expenditure of appreciable company funds (IRD and profits) to redesign their products to conform to the new standards specifications and in the process, certain key production techniques and know-how may be lost or compromised. In many instances, especially when future production requirements are unknown or quite uncertain, company management may be difficult to convince that the expenditure of company funds to comply with a new Air Force standard is good business strategy. Obviously, standardization will tend to limit competition.
>
> Increased standardization weakens the market position of smaller suppliers, such as ourselves, and will result in narrowing and stagnation in the avionics industry.

The minority opinion expressed was not significantly related to company size. Both large and small contractors expressed reservations concerning any level of avionics standardization. They fear that without the opportunity to compete for new programs with their individual company expertise, they may have to drop out of the bidding due to the limits that the various standardization levels place on market requirements. Some of the smaller companies in relation to Air Force sales volume did express certain individual company related concerns, however, they did seem to agree that standardization improperly applied would serve to decrease a competitive edge they may have obtained through innovative efforts.

> The avionics standardization levels may tend to affect our market position if we aren't allowed to be innovative in our technical designs. We find that most of our business is highly competitive. Our only hope for survival is to be allowed to use technological innovations, i.e., ideas that will allow us to accomplish the same end result using fewer parts or fewer manufacturing hours.

As can be ascertained from these comments, the Air Force needs to be cognizant of how they apply certain standardization levels so as not to drive some of the smaller or less competitive companies out of the market.

Effect on Equipment Availability

Majority Opinion

The optimization of avionics equipment availability is a goal that is being continually sought by acquisition and support managers within USAF. Avionics standardization levels can be a prime driver in obtaining these goals. The majority of the respondents to our second open-ended question, "How do you perceive each of these levels of standardization will affect USAF equipment availability?" felt that benefits could be derived. Their sentiments can be summarized in the following comments:

> As to standardization affecting equipment availability, there is no doubt in my mind that availability should be directly proportional to standardization. Commonality of installed equipment means commonality of spares, less dilution of experience and skills, more efficiency in the maintenance shop; in short, all of the good factors for achieving highest availability.
>
> Equipment availability for the Air Force would be greatest at the maximum standardization level. This would be because greater purchases could be made enabling the purchaser to enjoy lowered price due to learning curves. At the same time reduced R&D costs would result in total acquisition cost being lowered. Maintenance and cost associated with ownership could be reduced significantly because of greater efficiency, lower maintenance personnel, tech pubs, spares ordering, etc.

The majority of the contractors agree that equipment availability would be most enhanced by adopting the maximum standardization level. While they did express certain concerns in this

area such as suitability of equipment, quality and obsolescence; the majority opinion pointed out how the Air Force would benefit from a flexibility of interchange of parts and a simplification of maintenance requirements. The maximum standardization level was deemed to be most beneficial; however, there did seem to be considerable doubt as to whether this level could ever be actually implemented.

Minority Opinion

While the majority of the respondents felt that varying avionics standardization levels would enhance equipment availability, a smaller number of the respondents perceived that these levels would have an adverse effect.

> The levels of standardization we believe will affect USAF availability because new systems will be hard to develop under the standardization guidelines. Companies may tend to look for other fields to endeavor where they can be technically superior as opposed to compatibly standard with the competition. For that reason, the Air Force could see themselves going through a period of continual utilization of existing technological hardware. New systems may not come about as readily.

> Unless the Air Force maintains concurrent qualified multiple suppliers, delivery schedules may be stretched out impacting delivery of equipment.

The minority opinion of the respondents expressed concern over the implementation of any standardization level. Specifically, they expressed doubt as to whether the current or maximum levels would be practical in a changing tactical and technological environment.

> If awards are strictly to low bidder, the MTBF and MTTR could cause a lower aircraft availability

than you have today. However, with quality-criteria awards, the products should be good and not hurt aircraft availability.

In essence, these contractors believe that suitable equipment may become less available with increased standardization.

The responses in the area of the effect of each of the standardization levels on equipment availability were fairly explicit. There was a clear majority and minority opinion on the subject. Equipment availability is an important subject for the USAF to consider, especially in light of limited funding and the logistical costs of supporting older weapon systems. It seems that the contractors feel that the USAF should review its standardization procedures in avionics to keep equipment available to meet ever changing mission requirements.

Effects on Acquisition Cost

Majority Opinion

The subject of the effect of standardization on acquisition cost for avionics systems to the USAF is a matter of great concern to the contractor community. Ever-increasing price tags for these systems will result in fewer acquisitions by the USAF for much needed weapon system capability. In general, the respondents to our question "What effect would these standardization levels have on USAF acquisitions cost for avionics?" felt that these levels would increase acquisition costs. The majority opinion of these contractors can be capsulized in the

following comments:

> Avionics standardization will have the general effect of increasing USAF acquisition costs for avionics... The principal increase in costs will result from the limited competition which avionics standardization will bring about..It will therefore be difficult for more than one of two suppliers to maintain a current production capability, especially for products which require highly specialized test equipment and uniquely skilled personnel. In many instances it is probable that standardization will result in sole source acquisitions.
>
> Acquisition costs benefit from the larger production quantities associated with standardized procurement; but these benefits are offset by increased cost due to the greater complexity of standardized equipment necessary to adapt it for use in more than one type of aircraft, the inhibition of cost decreases made possible by the introduction of new technology, the decrease in competition as fewer equipment suppliers dominate the avionics marketplace, and the reduction in initiative of prime contractors to seek lower cost alternatives in order to comply with standardization directives. These adverse effects are extremely significant in avionics acquisition due to the rapidly changing technology that is characteristic of electronics at this point in time. It is concluded that acquisition costs will not decrease significantly by invoking standardization measures.

In the opinion of the authors of these statements, standardization avionics components and end items will result in increased acquisition cost, or at best, little appreciable savings to the USAF. Cost savings could result due to economics of scale in producing greater quantities of avionics. However, these economics must be tempered with the requirement to maintain a competitive environment.

> Initial first production run acquisition costs should be favorable to the Air Force due to the competitive nature; however, unless multiple sources are maintained, the following production buys may have a tendency to increase in cost due to lack of competition.

> Maximum standardization on elements and subsystems will minimize USAF acquisition cost for avionics if a competitive environment is maintained over the total acquisition phase for the standardized functions. Various experience has shown how prices have risen dramatically when competition was no longer available for government procurements of avionics. Failure to maintain competition for standard functions could lead to the Minimum Standardization level being lowest in acquisition cost.

Maintaining a competitive environment is of prime concern from the majority of the respondents. As the "buyer" for these sophisticated avionics systems, the USAF must take adequate measures to maintain a competitive marketplace among the contractor community. In addition, the USAF must insure that new technology can be infused into standardized systems, and maintain the contractor's initiative to provide this technology.

Minority Opinion

A smaller number of respondents felt that standardization would actually reduce acquisition costs to USAF.

> Avionics acquisition costs to USAF will be affected by standardization in two basic ways:
>
> 1. Through economy of scale.
> 2. The level of sophistication at which standardization occurs.
>
> In the first instance, greater numerical quantity of acquisition implies lower costs due to use of improved methods, process, production techniques, and tooling warranted by the larger production runs. Also, focus of engineering development efforts on a limited number of genetic types of avionics systems could be expected to result in development costs lower than those involved in discrete developments of specific weapon system applications within each genetic type. However, whether or not these economics of scale are realized, depends upon the aggregate cost of the separately developed and acquired subsystems. It is conceivable that maximum standardization would result in greater total

> acquisition cost (avionics + additional less capable vehicles) than lesser levels of standardization if the level of sophistication to which standardization is sought, exceeds some minimum level. Establishing this level and quantifying its cost implications to weapon systems requiring lesser or greater capability than the standardized level would appear to be a major consideration and major task facing implementation of maximum standardization.

Not only is the savings realized to acquisition dependent on numerical quantity, number of genetic types, and level of sophistication, but also on the actual level of standardization being sought by the USAF.

> There is little doubt that all three levels of standardization will lower acquisition cost of the standardized item, simply because the quantity buy will reduce unit cost. However, the quality buy advantages of the maximum standardization level may lower be offset by two factors. First, because the sensors will be used in many different weapon system applications, the fixed partitioning of functions may result in more capability being available than necessary. This increases the complexity and cost of the integration design task. Second, the maximum standardization tends to freeze technology advances so that after a period of time the acquisition cost would be substantially higher for an older (but standard) item than for a newer, more advanced system. The well-known trend in electronic devices having more functions per unit cost will often negate the cost advantages of large quantity buy. On the other hand, the minimum standardization level may not lead to substantial acquisition cost savings, since the developmental costs must be absorbed by the single aircraft program. If developmental costs are not spread over more than one aircraft program, the benefits of using an already developed, standard unit will not be fully exploited.

In conclusion, acquisition cost for avionics system could be affected by standardization. The competitive nature of the contract award, economies of scale, the genetic system types, and the levels of sophistication and standardi-

zation affect the cost or savings to the USAF. USAF acquisition and support personnel must thoroughly investigate each of these vital areas of concern, before deciding to implement standardization specification on major or minor avionics systems.

Effects on Ownership Cost

Majority Opinion

Ownership cost of major weapons systems is of prime concern to both the USAF and the contractor community. As with acquisition cost, every-increasing costs of weapons system due to life-cycle ownership cost, will have an adverse effect on both the USAF and the contractor. Limited funding availability and upward spiraling costs will result in fewer avionics component and end-item procurements. These fewer procurements will cause a reduction in sales to the contractors and ultimately a reduction of our avionics technological development and production base. This reduction in base will adversely affect the USAFs mission capability and further reduce its operational efficiency to counter any threat to our national interests.

Avionics standardization initiatives are proposed by the USAF to more effectively utilize our limited funding. The majority of respondents to our question, "What effect would these standardization levels have on USAF ownership cost for avionics?" felt that these levels would decrease ownership cost. The majority opinion of the respondents can be summarized in the following statements:

> The cost of ownership could improve (go down on a unitized basis) directly proportional to the degree of standardization of avionics boxes. The cost of spare units, modules, and even piece-parts, will be lower (per unit) for the higher volume, longer term of procurement involved in supporting the across-the-fleet standardized avionics box than for the tailored-to-specifics-model-airplane type avionics box. The advantages of having maintenance shops, and the maintenance personnel, working on a limited variety of equipment enhances their capabilities and efficiency, lowering the cost of maintenance actions compared to the same shop and personnel maintaining, say, five varieties of the same kind of avionics box.
>
> It is possible that standardization measures applied to limited areas of avionics procurement will reduce support equipment and training costs to a degree that effects a worthwhile cost savings. If applied indiscriminately; however, standardization could be very expensive. What is the cost associated with inferior weapon capability: What is the price of freedom?

These respondents support the position that standardization will result in a reduction in the ownership cost of avionics. As with acquisition cost, economies of scale brought about by implementation of standardization specification in avionics procurement will result in ownership cost savings. In addition, reduction in the requirement for a large number of unique items of support equipment, and a concentration of training requirements to a smaller number of avionics components, will result in significant savings. Savings can also be realized by the selection of the proper level of standardization.

> In general for all three standardization policies the higher the standardization level the lower the total ownership costs. Achievement of these reduced costs could best be guaranteed through early increased R&D spending for component and device technology prior to a weapon system development. Concurrent development of both devices and weapon systems over a short time span and increased demands for added

weapon system sophistication are the large contributors to not realizing realiability, and hence availability goals.

Strictly from an Integrated Logistic Support (ILS) viewpoint and defining "Ownership Costs" as the cost of operation, maintenance, and follow-on logistics support -- maximum avionics standardization is preferable. This level of standardization will result in the lowest cost of ownership in comparison to minimum and current policy levels because of the following:

- Non-recurring development costs of maintenance training/trainers, ground support equipment and technical manuals are spread across many aircraft programs rather than each program incurring its own cost for developing these commodities.

- The recurring costs for spare parts, ground support equipment, training, and technical manuals are reduced due to the economy of scale. The high cost of peculiar avionics Ground Support Equipment (GSE) for different avionics systems in different aircraft can be reduced through maximum avionics standardization and utilization of the same GSE across these aircraft.

- The cost of personnel will be reduced by the ability to utilize the same personnel for different aircraft. The greater the number of common LRU's will also permit more efficient work loading and scheduling of maintenance personnel.

- Spare parts can be procured in larger quantities -- resulting in lower unit cost -- and can be stocked more efficiently for local issue and in centralized supply points. The breadth of line items can be significantly reduced with the attendant reduction in inventory management. In addition, for minimal additional costs large quantity parts procurements may justify utilization of high reliability screened components.

In general, the cost of ownership of a system will be lowered by all standardization levels, with the lowest cost of ownership being achieved with the maximum standardization level. However, if the standard item is used over a long period of time (i.e., 10 to 15 years), the differences in reliability between the standard item and a new item using advanced technology may negate the supportability advantages of the standard item.

Maximum standardization, as defined in Chapter Two, was clearly the level that the contractor felt would result in the best cost savings opportunities for the USAF. As can be noted from the last statement, the period of component utilization would have an effect on this savings position. In addition, competitive market concerns were again expressed by the respondents.

> In this area, Ownership Costs would be minimized by maximum standardization on elements and subsystems where the procurements were limited to one design for each standard function. This will clearly provide the lowest cost unless the repair capability is limited to one supplier who is able to charge "what the market will stand." The area of ownership cost presents a natural conflict to acquisition costs in relation to competition. If competition is used in acquisition to obtain best costs, this naturally tends to require greater support costs. However, in modern avionics, acquisition costs tend to have a significantly greater effect on life-cycle costs than to ownership costs. Therefore, it is believed that emphasis should be on the benefits of competitive standards in acquisition and that the elements that make up the ownership cost adjust to minimize their cost impacts recognizing the variance in standardized elements and subsystems.

In conclusion, the avionics contractors who responded to this question strongly support the idea that standardization of avionics can reduce ownership cost to the USAF. Savings caused by economies of scale, a reduction in the types of support equipment needed, use of fewer personnel to support these systems, and a reduction in the amount of proficiency training required by these personnel will be beneficial to the USAF. However, as with acquisition cost, USAF must critically review the individual and collective effects of

these potential savings areas before a decision is made to implement standardization specifications on major or minor avionics systems.

Minority Opinion

One of the respondents expressed the opinion that avionics standardization initiatives would increase ownership cost to the USAF. This opinion is presented due to the implications presented between Form, Fit, and Function and Standardization of avionics interfaces. Additionally Reliability Improvement Warranty (RIW) implications are surfaced.

> Ownership costs will also be increased. Currently, new standard specifications are based on the standardization of interfaces, or form, fit and function. This means that the avionic sensors or equipments affected are not composed of the same or identical internal parts. What effect this circumstance will have on Air Force logistics costs has not yet been experienced. Neither has the effect of RIW policies been evaluated as yet. In my opinion, standard specifications should be based on products or equipments which have been in use for an appreciable period of time and which have been well accepted by the users. Introduction of entirely new standards such as those based on the Avionics Laboratory Digital Avionics Integrated System (DAIS) will undoubtedly result in increased ownership costs.

As can be ascertained from the above comment, major and minor weapon system acquisition processes and ultimately end item production are extremely complicated and interrelated activities. Affecting one area, such as standardizing avionics components, can start a chain reaction, or ripple effect, that could drive ownership cost higher, and not result in the savings that were originally planned. USAF acquisition and support managers must be aware of these

reactions and effects in order to deal with them, and keep the original goal of ownership cost savings on track.

Effects on Technological Advancement

Majority Opinion

The ability of USAF avionics systems and requirements to adapt to future threats and innovations is a basic necessity in maintaining our weapon system capabilities. The majority of the respondents to the fifth open ended question, "How do you perceive these levels will affect technological advancements in avionics research and development?" felt that standardization will adversely affect this advancement. Their overall opinion can be capsulized in the following statements:

> Standardization, by its very nature, acts as a disincentive to innovation. At the avionics system design level, the mandatory use of standard avionics severely constrains design freedom and the opportunity to incorporate new approaches to the implementation of required mission functions. At the subsystem level, the fewer developmental programs that accompany use of standard avionics will slow the pace of innovative solutions to the design and development challenges facing subsystem suppliers. One of these challenges is the cost reduction sought in new designs for both acquisition and support costs. With fewer design teams working toward cost reduction, one effect of standardization may be a reduction in the rate of progress toward less expensive implementation of required avionics functions."

> Adoption of higher levels of avionics standardization could potentially suppress company-sponsored IR&D programs. Furthermore, such a policy could have serious consequences operationally should primary avionics subsystems be compromised.

The responses received in the area of technological advancement being influenced by the various standardization

levels reflected a fairly definite position and a high degree of interest. An overwhelming majority of responses in this area reflected the position that increased standardization would impede technological advancement. New ideas in avionics could be delayed or not implemented as sources drop from the market. Fewer design teams would be available to work in this area. As a result, this could reduce the number of new innovative solutions to the pressing needs of supplying new avionics equipment in a rapidly changing environment. Basically, a narrow market could cause the industrial sources that we now have to shift to other interest areas. The extreme majority opinion of the responses stated that technology would be stopped at the maximum standardization level. While this probably would not occur, it does seem clear that in our sample, industry does feel strongly that standardization of avionics would be adversely affected if the USAF should press too strongly for increased levels of standardization.

Minority Opinion

A smaller number of the respondents felt that standardization would actually have a minimal effect on technological advancement.

> Standardization of avionics elements and subsystems up to the level of Maximum should not affect technological advancement in avionics research and development. The "should not" needs to be emphasized since it is possible to implement a standardization program in such a way as to completely stifle the application of new technology to USAF avionics.

A first requirement to encourage technological advancement and application is that there be a competitive environment in which improved products with genuine benefits can be introduced into standardized function markets.

A second requirement is that some means be developed to cover the initial start-up costs (development, tooling, test equipment, etc) for new technology products when they are ready to enter the market for a standardized element. The problem is that almost any product in production can be obtained in "add-on quantities for lower costs than a new product facing "first unit" costs. Earlier comments on possibilities of a "split-buy" approach to standard procurements apply here as well. This "split-buy" approach could allow a testing of the potentially superior product in the operational environment at a modest cost to the USAF and at an acceptable risk to the supplier.

A third requirement is that whenever possible, standards should be technology independent. Standards should specify the required form/fit/function and should not specify technology and should not include as requirements things that just happen to be characteristic of a particular technology but are not really required for mission purposes.

Another key requirement to encourage the development of new technology products in a standardized avionics environment is that an orderly well publicized plan be developed showing the anticipated major change points for new standardized function specification. This will allow suppliers to target advanced technology products for market entry at times when the most attractive competitive situation may exist. Conversely, they may avoid the problem of developing a new technology product to a standard specification only to find that the standard has been changed and the development effort wasted.

The minority opinion, as reflected in the preceeding quotation, was that standardization would not adversely effect technological advancement. Of the thirteen responses received in this area only two respondents felt that this was the case. However, they did raise some significant arguments.

> The maximum standardization level could be argued as preventing "advancements in avionics research and development. Personally, I think this is not necessarily true because in a competitive environment advancements are always in work. What could happen is that we could see some breathing room so that technological advancements could be brought about in a more orderly fashion. The minimum avionics standardization level is nominally seen to yield the greatest "technological advancements," but this is because every program has to have a new piece of equipment and newness is associated with advancement. I think everyone will agree that just because something is new it is not necessarily more advanced than its predecessors. Too often we have given up the good in pursuit of the better and gained nothing.

It may be necessary to take a more critical look at what we are trying to accomplish with technological advancement in avionics. In order to meet new mission requirements, the USAF should not intentionally stifle competition by standardizing to such an extent that industry goes to other areas, but on the other hand, technological advancement should not be sacrificed to keep non-competitive sources in business. Some sort of rational approach to this area should be devised to enable the USAF and industry to achieve maximum mutual benefits in this high interest area of great importance.

Degree of Standardization

Majority Opinion

The degree of avionics standardization that the USAF will implement in their weapons systems acquisition is of prime importance to the contractor. From the previous sections, contractor's reactions and perceptions have been noted concerning the effect of various levels of avionics standardization

on their company's market position, equipment availability to the USAF, acquisition costs to the USAF, ownership costs to the USAF, and technological advancements in avionics research and development. In this section, the respondent's position concerning, "what degree of standardization do you feel would be most appropriate?" will be presented. As a whole, the respondents felt that standardization specifications should be implemented in varying degrees depending on the individual mission requirements. Examples of these positions are as follows:

> Standardization can be most effectively applied to large volume production requirements; therefore DOD standards are preferable to USAF standards. Initially, standards should be developed for aircraft of a specific type; i.e. fighters, bombers, transports or missiles. General standards applicable to weapon systems of all types just are not feasible; therefore maximum level standardization is not practical.

> I personally feel we need to break it down to strategic, tactical and airlift type functions. Standardization for a family of aircraft being planned in advance could allow for an optimum utilization of technology and mature technology. For example: A GPS receiver could be the same for all aircraft while a fire control radar will have significantly different requirements for stabilization, motion compensation, roll rates, etc. In the latter case there may be a lot of LRUs that could be common, yet the peculiar differences do not allow interchangeability at the system level. The answer is that some pieces of equipment, TACAN, GPS, LIGHTS, SWITCHES, some communications equipment, engines etc. may have very broad base applicability and could be standardized while others pose unique requirements for the performance characteristics of the airframe, and a compromise may make the weapons system less effective; therefore, the overall weapons system attrition could cost much more.

As can be ascertained from these comments, mission requirements must be a prime motivator for the implementation of avionics

standardization specifications. However, a number of respondents supported the concept of implementing standardization at varying degrees depending upon savings in acquisition and ownership costs and increasing equipment availability.

> The current standardization level is believed to be the most appropriate. It is believed that the major advantage of a standard device or interface is it can lower cost of ownership, due to maintenance familiarity and spares availability. The major shortcoming of the minimum standardization level is that the full potential benefits of a standard cannot be realized if it is restricted to one aircraft system. On the other hand, the maximum standardization level will limit the technological growth of devices. The current standardization level will not limit technological growth or limit the benefits that can be derived in terms of cost of ownership.
>
> None of the three standardization levels provides the optimum situation for the Government. To the extent that systems have achieved maturity the "maximum" category should provide the best acquisition cost. To the extent that USAF (initially) and DOD (eventually) will support the cost of standardizating avionics items to the lowest essential level (for example, connectors) some standardization to the function level could eliminate all but the high performance, special design functions as high cost swingers. This would enable procuring agencies and contractors to concentrate on the high cost functions for purpose of cost improvement.
>
> The cost (to the Government) of configuration control in an environment of either "current" or "maximum" standardization could adversely offset the benefits otherwise realizable.

The implementation of standardization specifications based on a rational evaluation of mission requirements and logistics support savings must be followed by the USAF.

Standardization specifications should not be employed at only one level (minimum, current or maximum). Use of strictly one level would result in an adverse imbalance between benefits and problems associated with avionics standardization. Cost savings in the short run could be offset by increases in the long run due to reduction in technological advancements. Satisfying short run mission requirements on a fleet wide basis could result in long run deficiencies for particular mission type aircraft.

In conclusion, selection of an avionics standardization level must be investigated on a case by case basis. A shot-gun approach to this issue would be deleterious to the USAF. Standardization must be specifically targeted to realize its fullest potential.

Minority Opinion

There was a wide diversity among the respondents that did not support the majority opinion. However, there did appear to be a certain amount of agreement that the most appropriate level of standardization should be the maximum level. They felt that technology had advanced the avionics state of the art to a point where more standardization within reasonable parameters is possible.

> My personal opinion is that the maximum avionics standardization level is appropriate. In these days of micro technology, high speed chips, etc., one of the prime arguments against standardization, [illegible], is no longer valid.

Another opinion supported maximum standardization if it avoided the establishment of unique requirements that apply to only one weapons system.

> I believe that USAF standardization of avionics should be maximized and that there should be prohibitions upon development of equipment so uniquely electrically and mechanically fitted into one aircraft system so that it is virtually impossible to utilize it in another airplane. At the same time, I believe that standardization should be at the functional black box level, not at the plug-in module level (of course, standardization and required use of MIL parts is also to be maximized).

Basically, the respondents with the minority viewpoint concerning which degree of standardization is most appropriate felt that USAF could consider a greater degree of standardization in certain areas. They felt that large volume production requirements could be standardized effectively, but that it is necessary to specify these standards initially by aircraft type, i.e., fighters, bombers, or transports.

Special Concerns

In their responses to our six open-ended questions, the contractors voiced opinion about subjects they felt should be of special concern to the USAF. These concerns have been mentioned in the previous sections, however, further identification and clarification is required. These special concerns are as follows:

- o Competition
- o Multi-year procurements

- o Contractor Participation
- o Specialization versus generalization
- o System Program Office (SPO) priorities

Competition

The respondents to our open-ended questions continually expressed great concern about the relationship between effective avionics standardization specifications and a competitive market arena. The respondents felt that continued competition was vital to the success of USAF avionics standardization initiatives. The need for a competitive environment among contractors responding to USAF Request for Proposals or Invitations for Bids involving avionics standardization specifications is paramount to realize cost savings. The respondents' concern can be summarized as follows:

> These standardization levels ranging from Minimum to Maximum will not, in themselves, have any necessary impact on position in avionics markets for USAF applications. What is important is how the USAF structures competitive procurements and maintains competition for equipments in the face of increasing standardization. Past practices which in general did not include more than a minimum level of standardization at best provided many opportunities for competition to new and changing requirements. Even in these previous cases, certain "de-facto" standards evolved from selected source follow-on awards. At present, several avionics subsystems are being procured for USAF use. Among these are navigation equipments including the Standard Precision Navigator, the Standard Moderate Accuracy Navigator, the Standard Strategic Doppler Radar, and ARINC 561 Inertial Navigation Systems. In each of these cases, only one supplier is providing hardware to the USAF. There is at present no continuing competition for these elements.

> It appears that a procurement approach where a continuing competition is desired should include provisions that would split the initial procurement between the two or three best qualified sources. Although this may require greater initial USAF costs, follow-on procurements in a competitive environment may be maintained and subsequent division of procurement quantities can be based on actual supplier accomplishment in terms of cost, reliability and performances. Also, the procurement approach should focus on rewards as well as penalties. Another aspect of a suitable procurement approach is the manner in which logistic support problems affect source selection. It is suggested that where standardized avionics functions are to be procured, either complete contractor maintenance be specified or that standard intermediate level support equipment be required along with contractor depot support. Either of these approaches to logistics support eases the problem of multiple suppliers providing standardized form, fit, function interchangeable units.

These previous comments indicate that the contractors are deeply involved with the various ways that USAF procurements effect their markets. They indicate that standardization has a negative impact on competition as firms continue to be eliminated from bidding on new contracts as the number of companies necessary to meet USAF requirements dwindle. In many cases, free market forces enable the most efficient firms to thrive and to continue to provide top of the line equipment ot the USAF. This situation may be lost if the competitive structure is tampered with too much by non-competitive procurements. By applying ineffective standardization levels, certain sources of equipment may become lost that in the past have competed more effectively in an open market situation.

Multi-Year Procurements

In addition to the continuous reference to maintaining a competitive market environment, some respondents felt that the use of multi-year procurements would enhance both their position and the position of the USAF concerning effective implementation of avionics standardization specifications. The need for capital investment by the contractor community to develop and produce avionics components suitable for standardization initiatives will put a significant burden on the financial resources of both large and small contractors. Guarantees in terms of multi-year contracts for these standardized components will help offset the inherent risk of heavy front-end funding for required investment and justify this type of contractor funding profile. The contractors must have assurances that their significant investments will increase their sales position to the USAF. This position is summarized in the following respondent's statements:

> If a multi-year procurement plan was allowed, greater savings could be realized by the AF. The company could plan to optimize its resources such as production facilities, personnel and financing to produce the system more efficiently. If it (contract) is recompeted each year, great costs are incurred. Time is usually lost in the process of reflecting in higher overhead costs. It is my opinion that the initial production procurement should be for as long a period as possible to lock in the budgets. The initial competition should be an effective way to get the best price and utilize critical resources effectively. A high volume production firm may be penalized if there is a broad applicability not utilized. If a larger quantity is procured (current level) my company will do well because of volume production.....

> It (maximum level) affords highest volumes of production but may compromise the weapons system performance. Unless multi-year procurements are utilized and value engineering allowed in the development, costs will continue to be out of proportion. From a Defense Preparedness standpoint two sources are desirable. How does the government split the procurement? We have companies investing resources for an engineering development knowing full well that follow-on production will go the lowest bidder. This drives cost up.
>
> Put more money up front through competitive (where practical) Engineering Development and have multi-year production contracts for production, and maximum standardization will have an impact on costs.

As can be ascertained from the aforementioned statement, multi-year procurement could result in significant savings to the USAF due to economics of sales in production runs. However, problems can arise in the use of this type of procurement approach The relationship of development contracts to subsequent follow-on production contracts must be addressed and resolved. Additionally, the desirability of maintaining more than one source must be evaluated in light of the requirement for a competitive market environment.

Contractor Participation

A major avionics contractor expressed concern over the USAF use of quality-criteria or low bid criteria in the award of contracts for standardized avionics components. USAF selection of either criteria would result in non-response by the contractor.

> If the awards are not tempered by quality criteria, I would expect that___would not participate. In that type of competition, the only way to win on the average, would be to produce the cheapest possible product. If we did win, and put out a product that did not enhance our overall reputation, it would be

worse than no win at all."

> If the awards are tempered by quality criteria...,we would lose our ability to create a competitive quality product because all producers would be using essentially the same parts. I'm not sure that we would choose to put our name on a box that was not our design, even if there were quality-criteria."

This position could cause grave concern to the USAF. If avionics contractors will not produce copies of another contractor's specifications, the size of the avionics market place will decrease. With this reduction in responsive contractors, USAF can expect higher costs due to lack of a competitive position. The need for development and production of competitive quality products by the contractor must be weighed against standardization initiatives to obtain optimal savings.

Specialization Versus Generalization

Standardization initiatives in avionics must be selectively implemented. Certain weapons systems require highly specialized avionics technology while other systems can use generalized technology. The need for this distinction between specialization and generalization can be noted in the following comment:

> Standardization dictates compromise of specific requirements and results in generalization. obviously therefore, maximum level standardization is not feasible for certain types of avionics sensors, nor can it be generally applied to weapon systems which require highly accurate finely tuned, specialized sensors and/or equipments in order to accomplish their unique missions. Fighter and interceptor aircraft must have specifically designed sensors because the salient characteristics of these sensors may mean the difference between life and death for the pilot.

> Maximum standardization, as related to mission requirements, can be detrimental to specialized applications of avionics components. Specialization versus generalization benefits/problems must be addressed, evaluated, and resolved before a rational avionics standardization level is selected for a weapon system or a family of systems.

System Program Office (SPO) Position

The last area of special concern highlighted by the respondents is the priority that the SPO placed on USAF avionics standardization specifications.

> Typically a SPO must operate within a very restrictive budget and schedule. The SPO manager is not graded on how much standard equipment he uses but on how well he meets his schedule and cost goals, within the framework of the goals of his weapons system.

For these reasons mentioned above, or other reasons such as, lack of adequate direction or information on present avionics standardization initiatives, standardization of avionics is not receiving adequate attention. This lack of attention results in lost opportunities of optimal standardization, and ultimately, lower equipment availability, and higher ownership costs. Increased direction and emphasis by the highest levels of USAF is required to affect the savings that can be realized through a rational avionics standardization program.

Concluding Remarks

In conclusion, the contractor's concern in these areas should be heeded by the USAF. These contractor's are leaders in avionics research, development and production. Their concerns can have a direct impact on the avionics components

vitally needed by our sophisticated weapon systems. As can be ascertained from the aforementioned quotes, the contractor may not put his efforts and name on another's specifications, may require multi-year procurement to respond efficiently to USAF Request for Proposals, feels that System Program Offices do not care about standardization, wants competition through increased standardization, and perceives the requirement for a specialized generalized mix in avionics standards. To effectively satisfy the contractor, the USAF needs to take these concerns under advisement. In the long run the concerns of the contractor are the concerns of the USAF.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Introduction

This chapter presents the conclusions and recommendations of this research effort. The objective of the research was twofold. First it was to determine if a relationsip exists between various levels of standardization of USAF avionics components and contractor reaction to these levels in various areas. The second objective was to provide a forum for the contractors to express their individual opinions as to how standardization affects the areas in question and to analyze and report these findings. A summary of significant findings will be related to the five research questions and relevant conclusions will be drawn. In addition, this final chapter will conclude with a series of recommendations that may prove beneficial in formulating future avionics standardization policy, and also to identify areas that require further research.

Research Questions

Research Question One

Research question one asked if changing the levels of standardization in avionics acquisitions has an effect on his/her company's position. The respondents reported that changing these levels did have an effect on their position. Opinions stated generally expressed the viewpoint that increasing

standardization would adversely effect their position. As standardization levels increase, significant areas of trade-off occur as companies react to increasing costs and changing technology. They may bid on fewer contracts or may not even compete. The USAF needs to become cognizant of this reaction so as to not adversely affect the availability of contractors in the avionics market.

Research Question Two

The second research question dealt with the area of equipment availability. The contractors were asked if changing the level of standardization in avionics acquisitions will have an effect on USAF equipment availability delivered from the private sector. The responses in this area showed considerable agreement that increased standardization will enable the USAF to increase equipment availability proportionately. Savings in commonality of spares, less dilution of skills and experience, and more efficient maintenance will help achieve this goal. However, they did caution that a great deal of care should be used concerning the quantity, quality, and performance of equipment purchased.

Research Question Three

Question Three asked if changing the levels of standardization in avionics acquisitions has an effect on USAF acquisition costs as perceived by the private sector. A general consensus on the subject voiced the opinion that increased standardization will increase acquisition costs.

This increased cost is caused by the fact that many firms may drop out of the market due to their costs and increased technical complexity of equipment. Maintaining multiple sources is important to help control acquisition costs through competitive market forces.

Research Question Four

Research question four dealt with the area of ownership costs. Basically, it asked if changing the levels of standardization in avionics acquisitions has an effect on ownership costs as perceived by the private sector. The respondents felt that ownership costs would be affected. In general, they stated that ownership costs should improve in direct proportion to the standardization level employed. Increased standardization should serve to lower ownership costs due to savings in R&D, maintenance, and support costs, provided competition is not drastically reduced.

Research Question Five

The fifth and final research question concerned the area of technological advancement. The contractors were asked if changing the levels of standardization in avionics acquisitions has an effect on technological advancement. They did have some very definite opinions in this area which reflected a high degree of interest and concern. The major reaction was one that expressed the opinion that increased standardization could cause a significant decrease in industry funded research and development efforts. This could

have a detrimental impact on the USAF's ability to expand current state of the art avionics. Companies may tend to shift out of the avionics market to more lucrative areas, thus causing the dissolution of many presently well developed and skilled design teams. The USAF stands to benefit if a competitive environment is maintained that allows the contractors to utilize their vast resources and technological expertise to produce avionics products to fulfill USAF mission requirements.

Recommendations

The following recommendations are made based on the responses to both the structured interviews and the open-ended questions. In addition, the author opinions are included based on their background and analysis of the subject area. These recommendations require further definition and investigation for possible implementation within the USAF. The recommendations are divided into two categories which are Policy and Procedure.

Policy Recommendations

The following policy recommendations should be investigated by the USAF to enhance avionics standardization.

Maintain Competitive Environment. By maintaining a competitive environment, the USAF would benefit from the inherent efficiency of free market forces. These forces will ensure that the contractors will attempt to maintain cost viability and technological innovation to market their product. As

standardization levels increase, competition is adversely affected. Increased effort is required by USAF to offset this effect and keep the market competitive.

Strive for Multi-Year Procurements. These types of contracts will reduce capital investment risks to avionics contracts involving standardization specifications. The potential for guaranteed long term USAF contracts will cause contractors to expend great effort to meet our standardization goals.

Involve Contractor Prior to IFB or RFP. By involving the contractor community early in the conceptual aspects of avionics standardization program, the USAF will realize the full potential effects of the programs prior to contractual involvement.

Increase SPO Attention to Standardization. The SPO is the prime implementor of avionics weapons systems within USAF. Front end concern and attention to standardization initiatives must be achieved at this level to obtain optimal standardization benefits.

Procedure Recommendations

The following procedural recommendations are proposed to enhance standardization in the USAF.

Develop an Avionics Standardization Checklist. In this research effort, the authors have not discovered any source document that completely defines all the elements that must be defined for rational avionics standardization. Comprehensive checklists

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SELECTED EFFECTS OF CONTRACTOR REACTIONS TO STANDARDIZATION OF --ETC(U)
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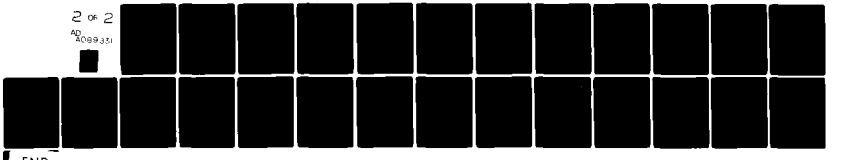

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should be developed to define these elements, and this checklist should be made readily available to all USAF acquisition and support managers.

Establish Government/Contractor Review Team. Avionics programs that have potential for standardization benefits should be reviewed by an unbiased and impartial Government/contractor team. This team review could ensure that both government and contractor concerns with standardization are investigated. Their recommendations could be more effectively utilized by high level USAF managers to determine a rational standardization approach to particular avionics mission requirements.

Sponsor Avionics Planning Conference for Contractors. Presently there is a USAF annual avionics planning conference to determine road maps for avionics development and production. The contractor community does not actively participate in this process. The contractors should be allowed to participate in this annual conference or hold their own conference under USAF sponsorship. This action would allow early participation by the contractors in avionics standardization planning phases.

Establish Deputy for Contractor Interface. The establishment of this office at AFSC, AFLC, or Headquarters USAF level could ensure an unbiased and impartial evaluation of reciprocal effects of avionics standardization.

Closing Remarks

The conclusions and recommendations brought forth in this thesis require additional research efforts. Specifically, the findings and special concerns listed in Chapter 4 are lucrative areas for further thesis study. A recent study by the Government Accounting Office on standardization reiterated the growing concern of the Federal Government to obtain maximum benefits from these practices. This study addressed a similar topic area on standardization but concerned ground support equipment. The GAO reported that contractors felt that standardization has an unfavorable image, explaining the functions and advantages of standardization is a difficult task, and justifying standardization by cost savings is a good way to advance it but it is difficult to measure. {13:10} In light of these most recent findings, and the findings of this thesis, it is clear that additional study is warranted concerning standardization. Finally, in relation to the topic of this thesis the scope of the study should be expanded to include more dependent variables such as competition, multi-year procurements and the issue of generalization versus specialization.

APPENDICES

APPENDIX A

BIOGRAPHICAL DATA

1. What is your company's name?
2. What services are provided to the USAF by your company?

   Consultant? Research and Development? Production?
3. What percentage of services provided to the USAF deal in R+D?

   None: 1-25% 26-50% 51-75% over 75%?
4. On an average, what is your company's total annual sales?
5. What portion of your company's total annual sales is directly related to the US Government?
6. What portion of your company's total annual sales is related to the USAF?
7. What portion of your company's total annual sales is related to avionics?
8. What is your present position title in the company? (Be Specific)
9. How long have you worked in the avionics acquisition field?

   (Total years with the government and industry)
10. How long have you been with this company?
11. What is your primary background?

    Engineering? Sales? Manufacturing? Etc?

APPENDIX B

INTERVIEW QUESTIONS

The following questions will require an answer based on the five point scale that you have before you.

STRONGLY DISAGREE DISAGREE NEUTRAL AGREE STRONGLY AGREE

The answers that you provide should reflect your particular reaction to each question in light of the given definitions.

1. The current USAF avionics standardization level is consistent with your company's position.

2. The minimum USAF avionics standardization level is consistent with your company's position.

3. The maximum USAF avionics standardization level is consistent with your company's position.

4. The current USAF avionics standardization level will decrease equipment availability to the USAF.

5. The minimum avionics standardization level will decrease equipment availability to the USAF.

6. The maximum avionics standardization level will decrease equipment availability to the USAF.

7. The current USAF avionics standardization level will increase acquisition costs to the USAF.

8. The minimum USAF avionics standardization level will increase acquisition costs to the USAF.

9. The maximum USAF avionics standardization level will increase acquisition costs to the USAF.

10. The current USAF avionics standardization level will increase ownership costs to the USAF.

11. The minimum USAF avionics standardization level will increase ownership costs to the USAF.

12. The maximum USAF avionics standardization level will increase ownership costs to the USAF.

13. The current USAF avionics standardization level will decrease technological advancement.

14. The minimum USAF avionics standardization level will decrease technological advancement.

15. The maximum USAF avionics standardization level will decrease technological advancement.

APPENDIX C

DEFINITIONS

Avionics:

All the electronic and electromechanical systems and subsystems (hardware, software, and firmware) installed in an aircraft or attached to it. Avionics systems interact with the crew or other aircraft systems in these functional areas: communications, navigation, weapons delivery, identification, instrumentation, electronic warfare, reconnaissance, flight controls, engine controls, power distribution, and support equipment.

Standardization:

The process by which the Department of Defense achieves the closest practicable cooperation among the Services and Defense agencies for the most efficient use of research, development, and production resources, and agrees to adopt on the broadest possible basis the use of common, compatible, or interchangeable supplies, components, weapons, or equipment.

Contractor Reaction:

The attitude of the interviewee concerning the effect of USAF initiatives on standardization of avionics.

Equipment Availability:

This is the measure of the degree to which an end item is physically on hand within an organization. This item must be operable and in a committable state at the start of a mission.

Acquisition Cost:

The cost of research, development, test and evaluation (RDT+E), production or procurement of the end item, and the initial investments required to establish a product support capability (e.g., support equipment, initial spares, technical data, facilities, training, etc.)

Ownership Costs:

The cost of operation, maintenance, and follow-on logistics support on the end item and its associated support systems. The terms "ownership cost" and "operating and support cost" are synonymous.

Technological Advancement:

The ability of the government or the private sector to improve the capability, effectiveness, or efficiency of existing avionics systems or to develop new avionics systems to counter existing or expected threats or deficiencies.

Minimum Avionics Standardization Level:

This level would require a particular piece of avionics equipment to be utilized on one particular weapon system. Examples would be a standard TACAN for all F-4 aircraft; a standard secure voice radio for all C-141 aircraft; and a standard bombing-navigation system for all B-52 aircraft.

Current Avionics Standardization:

This policy states that common avionics equipment that perform a particular function for more than one system will be used on more than one aircraft type. The technical requirements for this avionics equipment would emphasize wide applicability, use mature technology, have an architecture suitable for standardized interfaces and would be required in quantities large enough to realize savings in support costs.

Maximum Avionics Standardization Level:

This level would require that a particular piece of avionics equipment would be utilized on a fleet wide basis. Examples would be a standard TACAN for all USAF aircraft; a standard secure voice radio for all aircraft requiring this capability; and a standard bombing-navigation system for all bomber aircraft.

APPENDIX D

OPEN ENDED QUESTIONS

The following questions are open-ended and are intended to provide you with an opportunity to express your specific viewpoints on the standardization issues that are presented. The level of involvement on each answer to the question is left to your own discretion.

In light of the definitions for the three basic levels of standardization -- minimum, current policy, and maximum levels, what is your opinion in the following areas?

1. How will these avionics standardization levels affect your company's market position and avionics acquisitions to the USAF?

2. How do you perceive each of these levels of standardization will affect USAF equipment availability?

3. What effect would these standardization levels have on USAF acquisition costs for avionics?

4. How do you perceive these standardization levels will affect USAF ownership costs?

5. How do you perceive these levels will affect technological advancements in avionics research and development?

6. What degree of standardization do you feel would be most appropriate?

APPENDIX E

LIST OF CONTRACTORS CONTACTED FOR SURVEY

AAI Corporation
AIL Div. of Cutler Hammer
A-T-O, Inc.
Ampex Instrumentation
Amphenol Division
Applied Technology
Astronautics Corporation
AVCO Corporation
Bendix Corporation
The Boeing Company
Bunker Ramo Corporation
CAI
Cincinnati Electronics
Control Data Corporation
Cubic Corporation
Delco Electronics
Ford Aerospace
GTE Sylvania
General Dynamics
General Electric
Goodyear Aerospace
Grumman Aerospace
Hamilton Standard
Honeywell, Inc.
Hughes Aircraft
IBM Corporation
ITT Research Institute
ILC Data Devices
ITT Avionics Division
Kuras Alterman Corporation
Lear Siegler, Inc.
Ledex, Inc.

Logicon, Inc.
Loral Electronics
Magnavox Corporation
Martin Marietta Corporation
Robert Mayne & Co.
McDonnell Douglas Corp.
Motorola Corporation
Norden Div. of UTC
Northrop Corporation
Optical Coating Laboratory
RCA Corporation
Raytheon Corporation
Rockwell International
Rossow Associated
Sanders Associates
Sierra Research Corporation
Singer-Kearfott Division
Singer-Link Division
Sperry Division
Sperry Flight Systems
Sperry Univac
Sundstrand Corporation
Systems Engineering Laboratories
Systems Research Lab
Systran Corporation
TRW Defense & Space Systems Group
Technology, Inc.
Teledyne CAE
Teledyne MEC/Aertronics
Teledyne Electronics
Texas Instruments
United Aircraft Products, Inc.
Vought Corporation
Westinghouse Electric Corporation

APPENDIX F

LIST OF CONTRACTORS INTERVIEWED

AAI Corporation
Ampex Instrumentation
Amphenol Division
Applied Technology
The Boeing Company
Delco Electronics
GTE Sylvania
General Dynamics
Goodyear Aerospace
Grumman Aerospace
IBM Corporation
Litton Systems, Inc.
Lockheed Corporation
Loral Electronics
Magnavox Corporation
McDonnell Douglas Corporation
Motorola Corporation
Northrop Corporation
Sperry Univac
Teledyne Electronics
Texas Instruments
United Aircraft Products, Inc.
Westinghouse Electric Corporation

APPENDIX G

LIST OF CONTRACTORS RESPONDING TO OPEN-ENDED QUESTIONS

Amphenol Division

Applied Technology

The Boeing Company

Delco Electronics

General Dynamics

Goodyear Aerospace

Grumman Aerospace

IBM Corporation

Magnavox Corporation

Northrop Corporation

Rockwell International

Texas Instruments

APPENDIX H

DEPARTMENT OF THE AIR FORCE
AIR FORCE INSTITUTE OF TECHNOLOGY (ATC)
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433

FROM: AFIT/LSM 25 January 1980

SUBJECT: Structured Interview to Determine the Effects of Contractor Reaction on Standardization of Avionics Acquisitions

TO:

1. A team of graduate students from the Air Force Institute of Technology as part of their thesis is researching avionics standardization. There currently exists little published evidence to indicate whether or not the Department of Defense avionics contractors will accept, endorse, or support various levels of avionics standardization. An important aspect of the study is to determine contractors' reactions to various degrees of avionics standardization.

2. The researchers would appreciate approximately one half hour of your time to conduct a structured interview to determine your views on avionics standardization. All information will be held in strict confidence and will be used for research purposes only. To facilitate your responses, a series of definitions are attached for your review. Additionally, there are six open-ended questions that the researchers would like you to answer and return prior to 31 March 1980. This date is necessary to insure completion of the research study by the due date.

3. You will be contacted by one of the researchers to schedule the interview. Your participation and cooperation is greatly appreciated. If additional information is needed, please contact either:

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WARREN S. BARNES
Associate Professor of Logistics Management
Thesis Advisor

2 Atch
1. Definitions
2. Open-End Questions

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